Planning and costing of agricultural adaptation in the integrated hill farming systems of Nepal

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Acronyms and abbreviations

ADB	Asian Development Bank
AICC	Agriculture Information and Communication Centre
AMD	Agrometeorological Division
ASC	Agriculture service centre
CC	Climate change
CCM	Climate Change Management Division
CFUG	Community forest user group
CRISTAL	Community-based Risk Screening Tool – Adaptation and Livelihoods
DADO	District agriculture development office
Danida	Danish International Development Agency
DDC	District development committee
DFID	Department for International Development, UK
DFO	District forest office
DHM	Department of Hydrology and Meteorology
DIO	District irrigation office
DLS	Department of Livestock Services
DLSO	District livestock service office
DoA	Department of Agriculture
DoC	Department of Cooperatives
DoF	Department of Forests
DoI	Department of Irrigation
DSC	Department of Soil Conservation
DSCO	District soil conservation office
FAO	Food and Agriculture Organization of the United Nations
FY	Financial year
FYM	Farmyard manure
GCAP	Global Call to Action Against Poverty
GCM	Global climate model
GDP	Gross domestic product
GEED	Gender, Equity and Environment Division
GEF	Global Environment Facility
GIZ	German International Development Cooperation
GO	Governmental organisation
GoN	Government of Nepal
GTZ	German Development Cooperation (former name of GIZ)
IIED	International Institute for Environment and Development, UK

INGO	International non-governmental organisation
LAPA	Local adaptation plan of action
LMPD	Livestock Marketing and Promotion Division
LSC	Livestock service centre
LSSC	Livestock service sub-centre
MaSL	Metres above sea level
MCCICC	Multi-Sectoral Climate Change Initiatives Coordination Committee
MHS	Meteorological and hydrological station
MLD	Ministry of Local Development
MOAC	Ministry of Agriculture and Cooperatives
MoEnv	Ministry of Environment
MoF	Ministry of Finance
NAPA	*National Adaptation Programme of Action* (2010)
NARC	National Agriculture Research Council
NARI	National Agricultural Research Institute
NASRI	National Animal Science Research Institute
NGO	Non-governmental organisation
NPC	National Planning Commission
NRs	Nepalese rupees
NSC	National Seed Company Limited
PRSP	Poverty Reduction Strategy Paper
SDC	Swiss Development Cooperation
SEI	Stockholm Environment Institute
SQCC	Seed Quality Control Centre
SSM	Sustainable soil management
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
US$	United States dollar
VDC	Village development committee
WFP	World Food Programme

Executive summary

1. Despite an existing information gap in scientific evidence regarding the effects of future changes in climate patterns and options for the future, the community-based adaptation process should nevertheless be initiated. This requires community involvement through participatory planning in order to make use of local experiences and knowledge.

2. The existing technologies at the community level, and among researchers supporting communities in undertaking adaptations to climate change, are currently inadequately disseminated. While the generation of additional technologies is regarded as a priority in the long term, transfer of already available technologies to the user community should be the immediate priority.

3. The local adaptation plan of action (LAPA) is an effective means to mainstream adaptation options in national and local governmental plans, and to support local communities in planning for adaptation. Although the initial costs of defining this methodology are high, they will decrease as soon as it is evolved and scaled up. Hence, the adaptation costs and resulting benefits will also remain at the local level.

4. The majority of the adaptation actions identified for the hill farming system in Nepal are long-term actions. In order to achieve sustainability, the adaptation actions should not be part of any project or one-time investment, but must be integrated into the regular agricultural development process.

5. Adaptation priorities for the hill farming system of Nepal mainly incorporate improved practices for integrated soil, land, hedgerow and water management – for instance, through water harvesting and small-scale irrigation measures.

1. Introduction

1.1 Country background

Nepal is a small, landlocked and mountainous country with immense geographical and climatic variations. It is located along the southern slopes of the Himalaya between China and India, with a land area of 14,718 square kilometres (being 800km from east to west, and from 144km to 240km north to south), between 800 - 880 E longitude and 260 - 310 N latitude. The altitude of Nepal ranges from 72 metres above sea level (MaSL) to the highest peak in the world, i.e., Mt. Everest (8,848 MaSL). Of the total land area, 17 per cent is plain and the remaining 83 per cent is hills and mountains – 15 per cent of which are covered by snow, 37 per cent by forest, and about 18 per cent of which are used for agriculture (Pariyar 2008). Nepal is broadly divided into three agro-ecological zones varying in altitude, crop and livestock production systems: mountain, hill and Terai plain regions. Mountain regions account for 35 per cent of total land area, accommodating seven per cent of the total population; hills are 42 per cent of total land area with 46 per cent of the population; and plains constitute 23 per cent of land with 47 per cent of the population (MOAC 2004).

According to the 2001 census, 23.1 million people live in the country – of which 85.8 per cent are located in rural areas. Nepal’s gross domestic product (GDP) growth rate has been three per cent on average for the last decade. The estimated per capita GDP for the year 2008/2009 was US$467. The average population growth rate is 2.25 per cent per annum. According to the Nepal Living Standards Survey of 2003/04, about 31 per cent of the population were living at that time below the poverty line (CBS 2006); the figure has recently been estimated to be about 24 per cent (CIA 2011).

1.2 Agriculture as the mainstay of the Nepalese economy

Agriculture is the mainstay of the economy, accounting for about one third (31.1 per cent in 2009 - 10) of GDP (NRB 2010), which comes from 21 per cent of the cultivable land area – of which only 32 per cent is irrigated (Rimal and Rimal 2006). Agriculture employs 73.9 per cent of total employable people above the age of 15 (CBS 2008) and is not only a source of livelihoods but also a way of living for the majority of the population. However, agriculture is dominated by smallholder and marginalised farmers, with the average holding size being 0.8 ha (CBS 2002). Out of the 31 per cent of the population below the poverty line, 67 per cent are engaged in agro-based employment and 11 per cent as agricultural labourers; as a result the sector employs 78 per cent of the poor (CBS 2006). Since the vast majority of the country's population live in rural areas, they are highly dependent on agriculture as their main source of income (NRB 2010).

1.3 The intersection of food insecurity and climatic vulnerability

Although agriculture has been identified as the priority in development plans and main poverty reduction strategies, investment has fallen below three per cent of national budget. The national budget allocation to the Ministry of Agriculture and Cooperatives (MOAC) went down to one of the lowest levels, 2.45 per cent, in 2006/07 and 2.47 per cent in 2007/08. The implications of this are poor service delivery of agricultural extension and severe constraints for research and technology generation (Dahal and Khanal 2010).

Although the magnitude of the national food deficit has been less than one per cent of the total food requirement of the country, the spatial and temporal disaggregation is threatening. Recently, 40 out of 75 districts of Nepal have been declared to suffer from food deficits (MOAC 2009). Most of them are high hill and mid-hill districts of the western hill regions. At the same time, growth of the agricultural sector was low – only 1.1 per cent against the targeted rate of four per cent (MoF 2010). Superimposing the overall climate change vulnerability map with the food insecurity map, it can be seen that there has been a high level of intersection between the food insecure districts and districts with a high level of climatic vulnerability.

Table 1: Food balance of Nepal by ecological regions (Source: MOAC 2009).

Ecological Region	Net Edible Production	Requirement	Balance	Balance %	SSR (%)	PCEA (kg)
Mountain	296510	365701	-69191	-18.92%	81	155
Hill	2080755	2426366	-345611	-14%	86	172
Terai	2783135	2501249	281888	11.26%	111	201
Nepal	5160400	5293316	-132914	-2.51%	97	186

SSR = Self Sufficiency Ratio (per cent)

PCEA = Per capita edible availability.

1.4 The growth of the Nepalese economy and sensitivity to weather variability

The fact that the agricultural sector only contributes about one third to the total GDP is very much affected by existing weather variations. Prolonged droughts and unseasonal rains adversely affect rainfed agriculture to a large extent, accounting for an 11 per cent loss of rice yields, 7.1 per cent loss in wheat and 6.8 per cent loss in maize in the financial year (FY) 2009/10, which caused a total grain deficit of 400,000 tons. Meanwhile, the agricultural sector is expected to grow by four per cent in FY 2010/11, up from 1.3 per cent in FY 2009/10, largely because of higher output from key summer crops that benefit from these weather patterns (ADB 2011). The climate predictions reveal that climate variability is going to increase, making the largest sector of the country more vulnerable.

Of the 16 countries globally listed as being at 'extreme' risk of climate change impacts for the next 30 years, Nepal is in fourth position. This is based on the climate change vulnerability index, where poverty and adaptive capacity are some of the key determining factors in the ranking. While access to irrigation water is already low in the hills, large capital-intensive irrigation structures constructed in fragile hill environments are being exposed to a high risk of damage due to frequent landslides caused by unexpected downpours and flash floods. Moreover, the reliability of glacial melt as a source of irrigation water is being threatened. Irregularity observed in the pattern of the regional and seasonal variability of precipitation, and more frequent and intense floods and droughts, create a situation of uncertainty with respect to rainfed agriculture (Karkee 2008).

With the investment in agriculture and irrigation at low averages of 0.52 per cent and 0.55 per cent of GDP respectively, between FY 2006 - 07 and FY 2008 - 09, Nepal failed to make significant investments to build up adaptive capacities. This is especially pertinent since the poor are highly dependent on the sector for ensuring their livelihoods. Taking into account the sector's increasing vulnerability as a result of climate change, the judicious planning and implementation of corresponding adaptation actions in agriculture are also vital for achieving the overall goal of poverty reduction and improvement of social justice in Nepal.

1.5 Nepalese farming systems and altitude differentials

Agricultural systems and crops vary widely depending upon altitude and climatic conditions. Rice, maize and wheat are the major crops in Nepal. Low land and irrigated land in Terai plains and lower to mid-hills are characterised by rice-based cropping systems, with wheat, maize and cash crops as secondary productions. Upland and non-irrigated land (mainly in the hills) is characterised by a maize-based farming system. Agriculture in most of the hills – and even in some areas in the Terai regions – is composed of different crops and livestock integration to secure the self-subsistence of households. The high hills also have a unique farming system that is composed of upland and rainfed cultivation of potato, maize, buckwheat, barley and other minor millets, as well as livestock rearing.

1.5.1 The unique integrated hill farming system

The integrated hill farming system is characteristic of the low to mid-hills of Nepal. Around 40 per cent of the cultivated land, 31 per cent of the grazing land, and 50 per cent of the forests of the country are located in the mid-hills, predominantly arranged in terrace farming. Lower terraces, known as *khet* lands, generally have access to the irrigation that is necessary for rice-based cropping systems. Rainfed terraces located higher on the hill slopes, known as *bari* lands, are often used for maize-based cropping systems.

Photograph 1: Nepalese hill farming system in Salang in winter (photo taken by Bikash Paudel, 24 March, 2011).

The peculiarity of this type of farming system is that it is mixed, diverse and subsistence-orientated, since it has a close interaction between crops, animals and forests, which makes it very similar to the highland mixed and/or rainfed mixed farming system category of the Food and Agriculture Organization of the United Nations (FAO) (Hall *et. al*. 2001). Although the primary goal of this integrated farming system is the self-sufficiency of the farming households, the majority of them do not achieve adequate production to feed their families during the whole year. The system also offers only low market potential for agricultural outputs in comparison to imported products. However, some niches have emerged within this system through specialisation in fruit production (banana, pear, peach, mandarin orange and other citrus fruits in particular). Some of the areas also offer milk, other dairy products, and goat meat to sell in the market. Seasonal migration is also one of the critical features of this farming system. Often, hill farmers search for seasonal work opportunities during the winter period and return back to their fields during the peak period in the summer and rainy season.

The common cropping patterns of the integrated system in non-irrigated *bari* lands are: maize – millet/pulses (black gram/cowpea/rice bean) – fallow; maize – vegetable – fallow; maize – mustard/buckwheat – fallow, as well as maize – fallow. The common cropping patterns of irrigated *khet* lands are: rice – rice; maize – rice – fallow/*rabi* vegetables; summer vegetables – rice – rabi vegetables. [1]

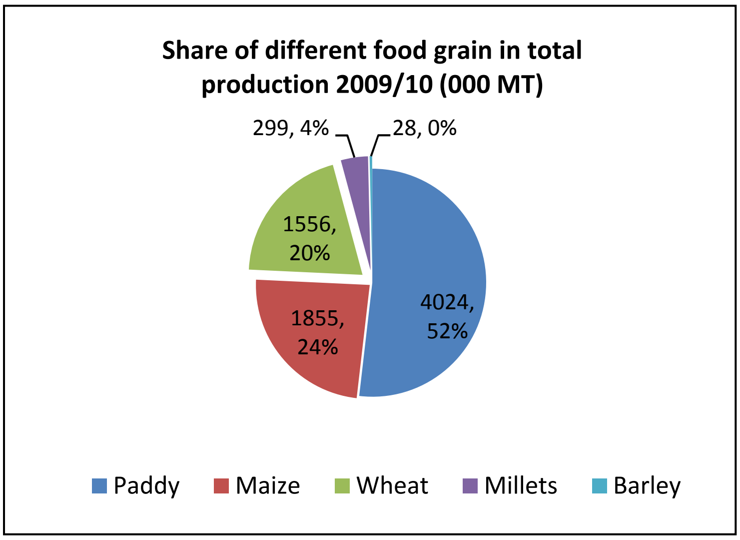
1.5.2 The importance of the integrated hill farming system to Nepal

Hill regions constitute about 42 per cent of Nepal's land area and accommodate about 46 per cent of the total population. The integrated hill farming system is important for national food security since maize and millets, two of the major food products of this farming system, cover together around 34 per cent of the land area (26 per cent and eight per cent respectively) and contribute about 28 per cent (24 and four per cent respectively) to food grain production. The system especially benefits the people residing alongside it, because populations in the hill and mountain districts of the mid- and far west regions are the ones who suffer most from food insecurity. The rate of underweight children under five years of age in the hill regions is estimated to be on average 39 per cent, and 48 per cent in the mountain areas (WFP 2009). This region has been identified as among the most vulnerable in the climate vulnerability analysis.

Figure 1: Share of different food grain in total area (Source: MOAC 2010).

[1] The crops that are sown in the winter season are called *rabi* crops. The *rabi* crop is the spring harvest (also known as the 'winter crop') in Nepal, India and Pakistan.

Figure 2: Share of different food grain in total production (Source: MOAC 2010).



1.5.3 The indifference of government policy towards the integrated hill farming system

The integrated hill farming system of Nepal has been subjected to climate variability in the form of irregular precipitation. Maize, as the major crop of the system, has been affected by unpredictable rainfall during the sowing time and other critical periods of moisture requirement. Recently, farmers have been experiencing the loss of most of the winter crops in the system – legume crops in particular have been found to be very sensitive to prolonged winter drought. Farmers have autonomously used different practices to adapt to these consequences, e.g., through searching for more drought-resistant varieties, changing the sowing time, double sowing, and looking for other crops that need less water in the winter season, etc. Such practices have not been successful in balancing the losses however.

National government policy has been indifferent regarding the integrated system because recent policies have focused on promoting agricultural commercialisation, which is difficult to achieve with a hill farming system because of the basic characteristics of the system – fragmented holdings, difficult terrain, and lack of irrigation and other facilities. Some programmes targeting the promotion of fresh vegetables and fruits in hill districts near to road access have been implemented. Nevertheless, all crops in this system, except for maize, have to a large degree been neglected in national research and extension.

2. Case study objectives and methodology

2.1 Objectives of the case study

The overall objective of this study is to contribute to the goal of providing guidance on how Nepal can adapt different agricultural systems to climate change through estimating the real costs of agricultural adaptation in developing countries. Additional goals were: analysing how agricultural adaptation can best be achieved based on the existing information on climate change, and looking strategically at the options for implementing and financing adaptation and mitigation in agricultural development.

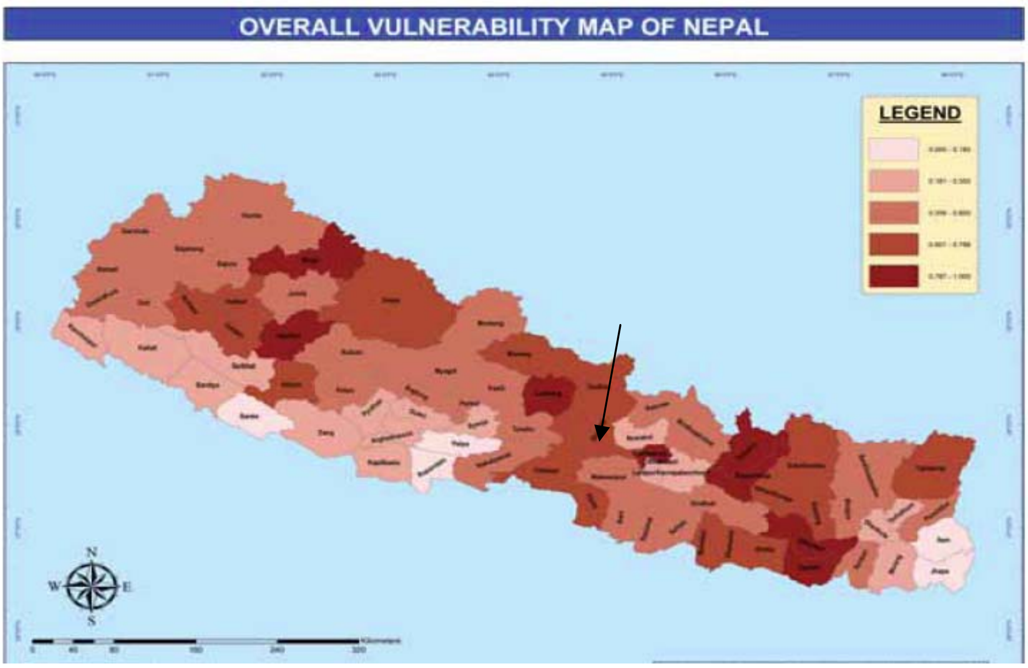
The specific objectives of the study are as follows:

- To review and analyse policies and plans of the agricultural sector in the context of challenges incurred by climate change and the need for adaptation.
- To analyse how maize-based upland farming systems are affected by climate change and to establish the corresponding adaptation pathway.
- To estimate the real costs of climate change adaptation for the maize-based integrated farming system.

2.2 Methodology for the case study

This study differs from many other studies that have looked at climate change adaptation at the landscape level with a certain geographical focus, since it will take a system's perspective by identifying the major climate vulnerabilities of an overall farming system. The study assesses how the farming scheme is already coping with changes and what other measures need to be implemented to make it more resilient. It also estimates how much extra investment – excluding the costs of regular service delivery and research – will be needed to establish the additional adaptation activities.

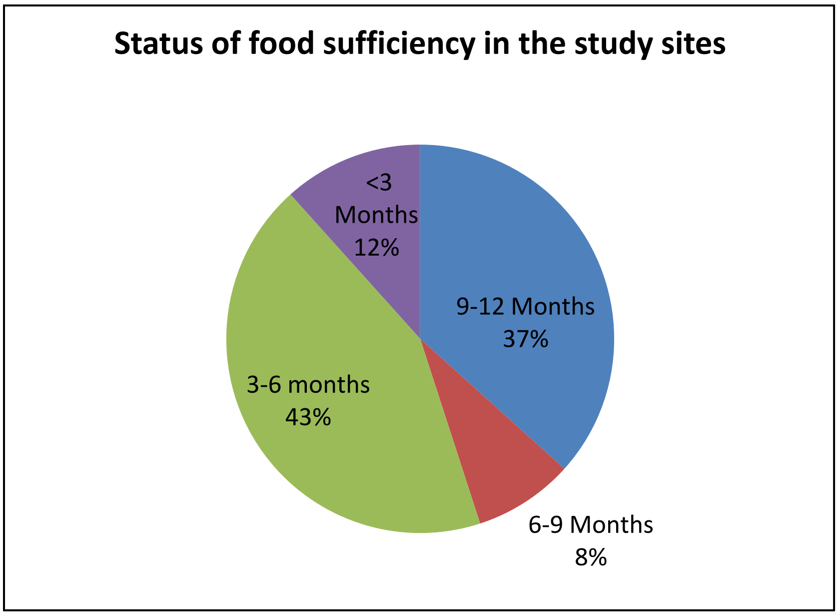
Figure 3: Vulnerability map of Nepal showing location of study sites (Source: MoEnv 2010).



2.2.1 General characteristics of the sites

The study was conducted in the Salang and Jogimara village development committees[2] (VDCs) of the Dhading District, which belongs to the climate vulnerability category B. About 89 per cent of the total population depends on agriculture for their livelihood.

Figure 4: Status of food sufficiency in study sites.



Jogimara VDC lies in the southwest of Dhading District in the mid-hill region of Nepal, having a warm temperate climate, hilly terrains and sloping lands. The altitude ranges from 292 - 1770 MaSL. The number of households in the VDC is 1,157 and the total population is 6,682. Eighty-five per cent of the population is dependent on agriculture for their livelihoods.

Salang VDC is located in the southwest part of Dhading District in the mid-hill region of Nepal, with a geographical condition very similar to Jogimara. The only difference is that Salang VDC is faces south and thus looks towards the hills of Nepal. Salang is drier compared to Jogimara VDC and accommodates about 1,014 households with a population of 5,907.

- The average size of the 60 households in the study sites (as estimated from the household survey) is about 6.7 people per household. Of the randomly-selected households, 65 per cent were Janajati, 28 per cent Brahmin and Chetri, and 5 per cent Dalits and others.
- The educational status of the areas is also not high generally, since the respondents were identified as: 33 per cent illiterate, 45 per cent literate, 10 per cent had a primary education, and 10 per cent were educated to secondary level.
- The overall food security situation of the sites is also very poor, as only 12 per cent of the households were found to be food self-sufficient during the study (Figure 4).

[2] The village development committee (VDC) is the lowest political body in Nepal. One set of committee members is elected from within a predefined geographical boundary but the area within the boundary is also known as the 'VDC'.

2.2.2 Agricultural characteristics of the sites

Photograph 2: Land prepared for sowing main season crops in the hill farming system (photo by Bikash Paudel, 24 March, 2011).

The agricultural system of the study sites is characterised by typical integrated hill farming. Although the households' target is to be self-sufficient in food production, more than 60 per cent of the households have to purchase food from outside. Maize, millets, minor millets and rice are the major food grains, while grains, legumes and mustard are the major cash crops. Some of the farmers in the study sites also grow commercial vegetables, mostly tomato and commercial fruits like mandarin and oranges, which are sold to the market by cooperatives in Kathmandu. Most of the agriculture is rainfed, which makes the production very sensitive to weather variations. The farmers are smallholders of whom 75 per cent hold less than 0.7 ha of land each. Farmers also keep some cattle, buffalo, goats and free-range chickens, which are well integrated into the system. In the winter time, young village people, in particular, search for seasonal employment outside the village. At the study sites:

- The average holding size per household is about 0.91 hectare.
- The sixty households hold 209 cattle, 99 buffalo, 405 goats, 16 pigs and 239 birds.
- Average household annual cash income of the sites is about NRs.57,868, with NRs.68,120 in Salang and NRs.47,616 in Jogimara. About 47 per cent of the total household income comes from the agriculture sector (selling fresh vegetables, selling livestock like goats, pigs, chicken and cattle, and other surplus).

2.2.3 Tools and techniques

Different qualitative as well as quantitative tools were used for the data collection in field.

A. Qualitative tools for planning of adaptation:

1. **Community-based Risk Screening Tool – Adaptation and Livelihoods (CRISTAL)**. The well-recognized CRISTAL tool was used to analyse the vulnerability and possible adaptation actions in the communities for the next 20 years. The climate change experts in the focus group discussions employed the tool in the study communities. In addition to the risk screening and vulnerability mapping, the project also identified the possible adaptation strategies for the communities.

2. **Farming system thinking**. In order to do the planning and costing for agricultural adaptation in Nepal, a system's approach was applied to evaluate the integrated farming practices.

3. **Climate envelope**. The climate envelope was developed based on the climatic data of nearby meteorological stations. The climatic data of Bandipur (27'56", 84'25", 965 MaSL), Rampur (27'37", 84'25", 256 MaSL), Dhading (27'52", 84'56", 1420 MaSL) and Gorkha (28'00", 84'37", 1097 MaSL) were analysed to generate the downscaled climatic envelope for the study sites. All these agrometeorological stations are within 10km air distance from the study sites. The climate envelope reflected the possible climatic scenarios of the study sites during the years 2040 - 60, based on historical data and complemented by respective simulations.

4. **Travelling seminar**. The study tried to blend the knowledge, experience and anticipations of the farming communities with the technical expertise and knowhow of development agencies, in order to optimise the planning and costing of adaptation in the agricultural sector. The travelling seminar was selected as a tool whereby experts from different backgrounds (agriculture, forestry, livestock, watersheds and the environment) could come together in the field to communicate with local communities and assist them to plan for themselves. Two separate travelling seminars in the two study communities were conducted, with the aim of generating the adaptation pathway and estimating the incurred costs of the adaptation signatures at the community level.

5. **Development of adaptation pathways**. The planning for adaptation to climate change in the integrated farming system was done by blending the farmers' knowledge and predictions with the knowledge of experts in agriculture, livestock, forestry and social sciences. A 'right to left' approach was used, i.e., anticipating a future goal and planning to achieve the goal against a specified time period that then generates the adaptation pathway for the integrated hill farming system. Based on the present context and future predictions regarding climate change, and the vulnerability of communities, the 'best case' scenario of where the community wants to be in 2030 was discussed in the groups. The agreed upon pathway consists of a combination of different possible activities through which the communities aimed at increasing their resilience and adaptive capacity.

B. Qualitative tools for costing of adaptation:

The costing was identified as an important but problematic part of the study. The steps used for costing the adaptation pathway were the following:

1. **Identification of adaptation signatures**. The combination of different activities that will lead the communities towards the anticipated goal of a resilient system in 2030 were identified through the exchanges between communities and the technical experts in agriculture, livestock, forests and water resources, and taken as the adaptation signatures.

2. **Project budgeting for the signatures**. The costing of the adaptation pathway was done by project budgeting for the corresponding adaptation signatures. Once the adaptation signatures were identified, their costs of implementation in the local communities were estimated through participatory methods and collaborative exercises. This was done by a participatory budgeting technique, i.e., preparing the total budget for implementing those activities in communities, districts and at the national level. It was also assumed that certain activities of the adaptation pathway will be facilitated and implemented – by external project initiatives or organisations – from now until 2030. The signatures were categorised into different groups to make the costing easier and more pragmatic.

3. **Immediate and long-term**. The adaptation signatures and involved adaptation activities were categorised on the basis of urgency, and sequenced in terms of activities that need to be implemented immediately and activities that need to follow on from these initial ones. In the analysis, the activities that need to be conducted within the next eight years were regarded as 'immediate' and activities to be adopted afterwards were defined as 'long-term'.
4. **Climate change adaptation and agricultural development**. The signatures were also categorised on the basis of whether they can be particularly linked to climate change adaptation activities, or whether they are part of general long-term agricultural development initiatives. However, a clear distinction cannot easily be made between the two. For the purposes of this analysis, those activities that have already been included (or will be included) in the agricultural development plans and policies of Nepal were classified as the activities for 'agricultural development'; and the remaining were characterised as 'climate change adaptation' activities.
5. **Costs at different levels**. The cost of implementing adaptation signatures is allocated to three different levels: community, district and national, and thus leads to three different calculations for the implementation of activities. Community-level costs are those that are needed to implement the adaptation signatures in the communities, including the material inputs, technical inputs, and social mobilisation costs. In the analysis, the costs that needed to be supplemented by the farming households were not included in the community-level cost calculation.

   Another set of costs is the cost of coordinating activities at the district level. In the study it was assumed that at least 20 villages in a district will implement similar types of adaptation signatures and district-level stakeholders – i.e., the district agriculture development office (DADO), district livestock service office (DLSO), district forest office (DFO) and district development committee (DDC) – will be given the task of coordinating, and based on that the possible district-level costs were calculated.

   The national-level costs are, due to limitations of scale and the scope of the study, only an anticipated calculation of the costs for coordinating and backstopping the activities in communities and districts across Nepal. It was assumed, for the purposes of estimating national-level costs, that at least 20 districts will implement a similar type of adaptation pathway.
6. **Costs for different stakeholders**. The most important stakeholders at the different levels, and their responsibilities in terms of implementation and costs, were identified and the costs of the adaptation signatures correspondingly allocated.
7. **Participatory budgeting**. The costs of each and every activity were estimated based on the participatory budgeting principle. Relevant stakeholders who had previous experience in the implementation of the particular adaptation signature and/or adaptation activities were consulted to estimate the possible costs of that activity and/or signature. Different stakeholders were consulted to estimate the costs of different adaptation signatures.

C. Quantitative tools for planning and costing of adaptation for agriculture

Household surveys of 60 randomly-selected households, 30 from each VDC, were conducted to collect the information regarding the costs that agricultural households in the system have already incurred due to current climate changes; what the major adaptation measures that they are adopting are; what exactly they want to do in respect of future anticipated changes; and how much they are willing to invest on those different types of adaptation activities. Based on this information, the information regarding household-level costs and readiness for adaptation was estimated.

3. Impacts of climate change

3.1 Increase in temperature; increase in intensity of rainfall; and longer dry spells

The climate envelope was prepared by using the climatic data of Gorkha station, which is about 10 km northwest from the sites, and has a similar altitude. A global climate model (GCM) was run to project the anticipated changes in temperature, rainfall and dry spell duration.

Figure 5: Projection of the monthly average maximum temperature.

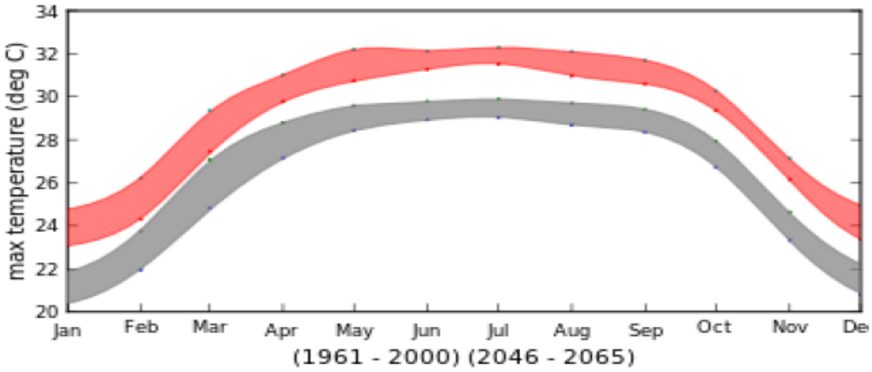


Figure 6: Projection of monthly average precipitation.

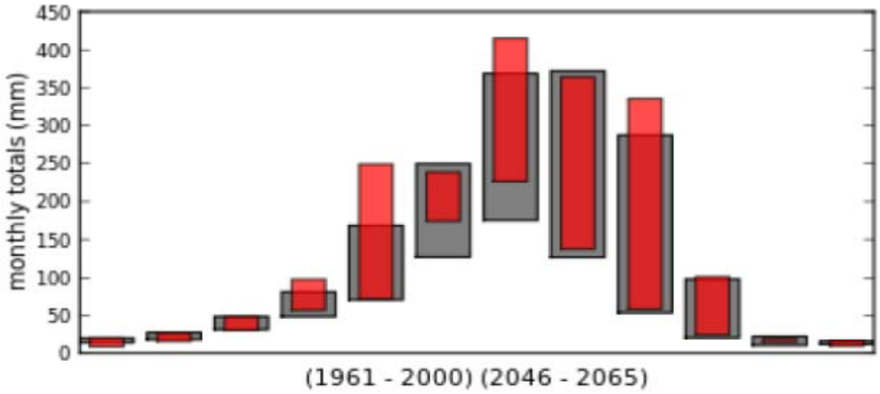
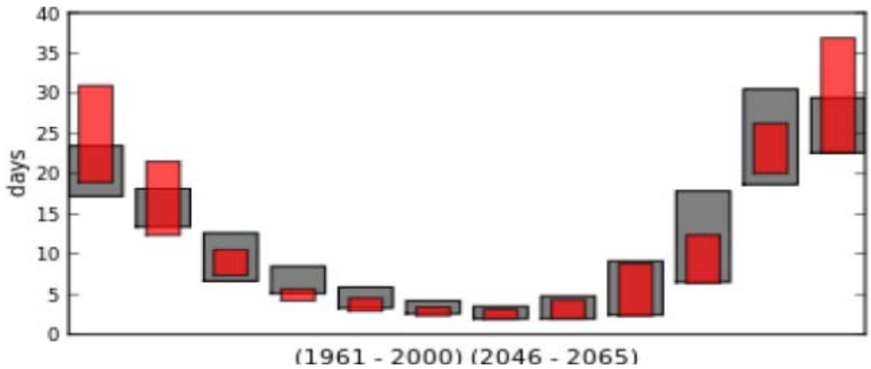


Figure 7: Projection of monthly average dry days.



Note: Grey shading/bars represents 10th to 90th percentile range of the control period multi-model projections (1961 - 2000). Red shading/bars represent the same but for the future period multi-model projections (2046 - 2065). The first bar represents January and the last one December.

As the analysis shows in Figures 5, 6, and 7, projected summer rainfall vis-à-vis total rainfall of the area will rise by about 20 per cent; this additional rainfall will occur during the rainy season. This will likely lead to a warmer and moisture-enhancing atmosphere, as well as a more intense seasonal cycle, resulting in a stronger monsoon season. The analysis also shows projections of longer dry spells during the driest part of the year.

Projected temperature changes are slightly higher than the global average, with an increase of nearly 2.5°C projected during the year. As mentioned in the observed climate trends subsection below, since Ghorka experiences summer temperatures of around 32°C, small changes in temperature significantly change the exceedance statistics.

3.2 Locally-observed trends are similar to the predictions

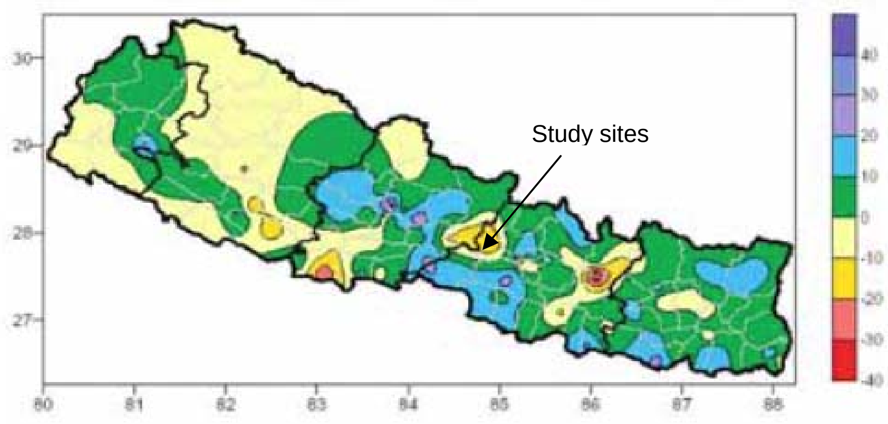
The changes that have been analysed by the models and the projections made by scientists coincide with the experiences of local people. They have already recognized some of the indicators of climate change, for instance:

- People are aware of the gradual temperature increase in the region. They have also recognized the decrease in the amount of cold days in winter, and experience more hot days today than in the past. Because of this, farmers have perceived changes in the physiology of the plants and animals they are keeping and as one of many consequences face new weeds and insect pests, which used to be a severe problem in warmer plain areas only.
- They have also noticed the increased frequency of extreme events in recent years, such as landslides caused by heavy downpours, as well as very long dry periods.
- The shortening and shifting of the monsoon season has also been recognized in the way that it commences and ends one month earlier. The prolonged winter droughts induced by the sparse rainfall and the changing weather trends in general have led to drier springs, challenging effective water resource management.
- Moreover, certain localised effects of climate variations appear as well. For instance, people in Jogimara faced a huge loss of summer crops because of hailstorms that happened during April 2008 and May 2009. Farmers in Salang mentioned that they had noticed the emergence of new diseases and insects due to the increase in temperature, and they also suffer from the problem of animal infertility.

3.3 Impacts of climate change observed by communities

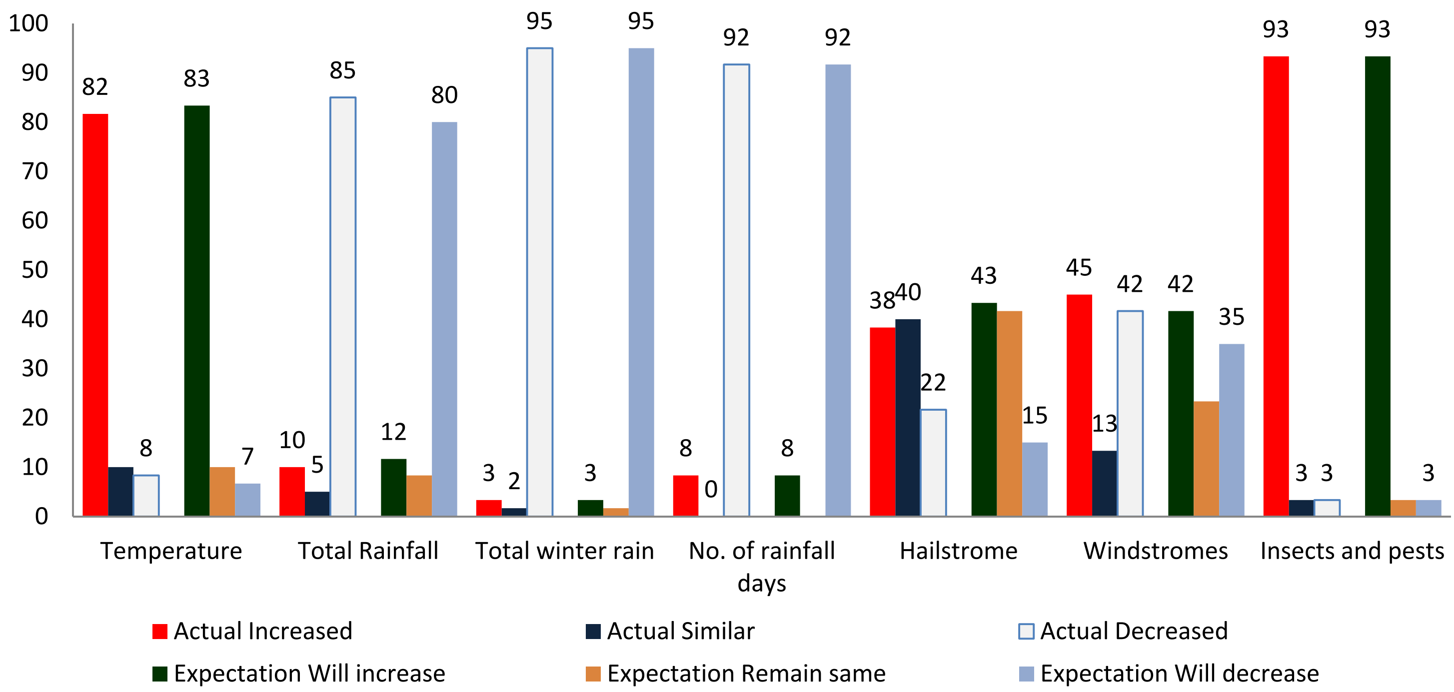
Change in precipitation in terms of decline and distribution has been identified as one major factor causing crop losses and thus putting significant pressure on the farming households. The overall precipitation trend map of the country shows that precipitation considerably decreased in the study sites as well (Figure 8). Another major cause is the occurrence of droughts during the critical crop cultivation period.

Figure 8: Precipitation trends (1976 - 2005) (Source: Practical Action 2009).



In the household survey, as shown in Figure 9, about 82 per cent of respondents answered that they have observed an increase in average temperature, and a similar number also expect this to increase in the future. About 85 percent of the total respondents answered that they have observed a reduction in the total annual rainfall, and about 80 percent also expect it to decrease further in the future. About 95 percent of the farmers have seen a reduction in the total winter rainfall, and also expect it to reduce further in future. The condition is similar regarding total number of rainfall days, which is observed to be reduced and expected to reduce further by about 92 per cent of the respondents. There was mixed perception about hailstorms: about 38 per cent of the total respondents answered that the frequency of these events had increased and about 43 per cent of them expect that this problem will increase further in future. Around forty-five per cent of the total respondents answered that the problem of windstorms has increased in recent years, and 42% expect this to increase further. Similarly, about 93 per cent of the total respondents answered that there is tremendous increase in the incidence of diseases and pests.

Figure 9: Percentage of respondents perceiving changes in climatic variables.



3.4 Effects of climate change on the farming systems

3.4.1 Perceptions of the respondents regarding changes in productivity of major crops/animals in the farming system

The perceptions of the households surveyed regarding different changes in climatic variables and the effect of those changes on their agriculture systems were recorded. Table 2 shows a summary of responses regarding observations on the productivity trends of the major crops and animals in the hill farming system, and a summary of farmers' expectations regarding the future productivity of these crops and animals.

Table 2: Perceived and anticipated changes in the productivity of major crops/animals in the farming system.

	Historical trend (20 years ago and now)				**Future expectation (now and after 20 years)**				
	Average percentage increase in productivity		*Average percentage decreased in productivity*		*Average percentage increase in productivity*		*No change*	*Average percentage decreased in productivity*	
Maize	25	(1.7)*	47	(85)			1 (1.7)	63.2	(86.7)
Cowpea	39.1	(20)	40	(58.3)	39.4	(13.3)		50.9	(61.7)
Black gram	5	(1.7)	43.6	(68.3)	90	(5)		45.7	(61.7)
Other legumes	45	(5)	47.4	(41.7)			1 (1.7)	40.2	(51.7)
Finger millet			57.3	(31.7)			1 (1.7)	39.5	(33.3)
Main season rice	25	(5)	37	(33.3)	25	(5)		41.5	(38.3)
Summer rice	50	(5)	36.7	(23.3)	60	(5)		35	(21.7)
Mustard	19	(8.3)	45.7	(45)	28.7	(6.7)		46.1	(43.3)
Groundnut			50	(5)				75	(5)
Vegetables	40.5	(46.7)	25	(3.33)	37.6	(45)		37.5	(3.3)
Cattle/buffalo	37		37	(70)				43.6	(68.3)
Birds	21.6	(10)	35.7	(40)	28	(8.3)		45.7	(33.3)
Goat	22.5	(10)	41.5	(43.3)	25	(8.3)	1 (1.7)	48.6	(41.7)
Fruits			15	(3.33)				40	(10)

**Figures in parentheses indicate percentage of total respondents giving such response.*

It can be observed from the table that majority of the respondents observe/perceive that the productivity of the major crops in the farming system has been in a decreasing trend. More than 85 per cent of respondents perceive that their maize productivity has decreased by about 47 per cent in recent years, and most of them expect it to further decrease in productivity into the future. More than half of the respondents perceived that the productivity of cowpea and black gram has decreased by about 40 and 44 per cent respectively, and expect it to decrease further. (The percentage of respondents perceiving that productivity has reduced in recent times is high for all crops and animals, except for vegetables). A more alarming aspect of the analysis is that the percentage of respondents expecting that productivity will further decrease is also high in all crops except vegetables – vegetables (the cash crop at the sites) are cultivated by using a modern and intensive input system. So the productivity of vegetables is in an increasing trend and people expect to increase their productivity further.

Farmers' perceptions about the increase and decrease in productivity of any crop or animal might be viewed as a crude estimation of the trend (and likely to comprise a large sum of errors). There again, their perceptions can be seen as reflecting general trends, and as such farmers' perceptions play a large role in decisions about production systems and agriculture adaptations to climate change.

3.4.2 Major causes perceived by farmers for the decrease in the productivity of major crops/animals in the farming system

The farmers perceiving that the productivity of the major crops and animals in the farming system has decreased were also asked about which major causes they believe have been reducing their productivity. The summary of the perceptions of farmers of the major causes reducing their productivity are categorised by different crops and animals, as presented in Table 3.

Extreme drought during the critical period of the crop cycle was found to be a major perceived cause of productivity loss for maize (57 per cent of respondents) and summer season rice (eight per cent of respondents). Increases in diseases and pest incidences were found to be the major perceived cause of loss in productivity of cowpea (37 per cent of respondents), black gram (22 per cent of respondents), other legumes (15 per cent of respondents) and mustards (17 per cent of respondents). Decrease in total rainfall days was found to be major perceived cause for productivity loss in finger millet and main season rice (ten per cent of respondents for both) and groundnut (five per cent of respondents). For vegetable growers, about seven per cent of total respondents responded that there are increased incidences of insects and pests in vegetables and they have to expend more money and time in controlling these pests. Increased incidences of hailstorms and windstorms have been identified as the major perceived problem for fruit crop productivity. For livestock, the major perceived causes in a drop in productivity are increased incidences of infertility and diseases, increased de-forestation, lack of drinking water, and the labour shortage.

Table 3: Major perceived causes of loss in productivity as perceived by respondents.

Crops	Major perceived causes of loss in production															
	Increase in temperature		*Decrease in rainfall days*		*Extreme droughts in critical periods*		*Decreased winter rain days*		*Increase in insects pests*		*Hailstorm , windstorm*		*Replaced / replacing other crops*		*Others*	
Maize	7	(11.6)*	5	(8.3)	34	(56.7)	1	(1.7)	2	(3.3)	1	(1.7)				
Cowpea			6	(10)	2	(3.3)	3	(5)	22	(36.7)	0					
Black gram	3	(5)	10	(16.7)	5	(8.3)	1	(1.7)	13	(21.7)			6	(10)		
Other legumes			4	(6.7)	3	(5)			9	(15)			1	(1.7)		
Finger millet			6	(10)	5	(8.3)			1	(1.7)			3	(5)		
Main season rice			6	(10)	2	(3.3)	1	(1.7)	6	(10)	1	(1.7)				
Summer rice			4	(6.7)	5	(8.3)	1	(1.7)								
Mustard	1	(1.7)	3	(5)	7	(11.7)	1	(1.7)	10	(16.7)			2	(3.3)		
Vegetables									4	(6.7)						
Groundnut			3	(5)									2	(3.3)		
Cattle/buffalo	3	(5)	1	(1.7)					3	(5)					21	(35)
Birds	3	(5)	1	(1.7)					3	(5)					23	(38.3)
Goats	4	(6.7)					2	(3.3)	13	(21.7)					2	(3.3)
Fruits							5	(8.3)	4	(6.7)	10	(16.7)				

**Figures in parentheses indicate percentage of total respondents giving such response.*

3.4.3 Effects of reduced precipitation on the farming system

The lack of water has been observed in the form of reduced precipitation during the sowing period, prolonged winter droughts, and the drying up of the water sources in the study sites.

A. Drought during the sowing period and other critical periods of maize cultivation

Table 4: Cropping calendar and effects on the system.

Crops	MONTH											
	1	2	3	4	5	6	7	8	9	10	11	12
Maize	XX	X										XX
	¥¥	¥¥			¥				¥¥	¥¥	¥¥	¥¥
Rice		X	X		X							X
		¥¥	¥¥									
Millet												
					¥¥							
Legumes												
					¥¥							
Extreme drought	+++	+							+			+++
	+++	+++	++				+	+	++	++	+	+++

Note: The parts of the rows coloured grey represent the cropping period of a crop in normal weather in the past, while the parts of the rows coloured blue show the historical change in the cropping period due to climate change. The mark X indicates in which part of the cropping period drought used to affect a crop in the past, while ¥ indicates the part of the cropping period where drought is expected to affect the crop in the future. The mark + indicates the severity of the drought in a normal year in the past (grey row) and expected changes due to climate change in the future (blue row).

Photograph 3: Farmers sowing maize in dry soil (photograph y Bikash Paudel, 26 March, 2011).

The cropping calendar shown in Table 4 indicates that because of extreme drought, sparse winter rain, and a decreased monsoon period, the system has been facing the following serious problems:

- A delay in summer rainfall by one month has shifted the sowing time of maize. Sometimes farmers had to repeat the sowing. When they sowed maize for the second time, however, they did not get the same quality crop seed and suffered up to 40 per cent reductions in yields.
- A delay in sowing also affects income from other crops following the maize cultivation, i.e., legumes like cowpea, black gram and rice bean. Those crops will be affected in two ways:

a. The costs of sowing will be more than doubled since farmers have to sow by hand. When farmers' sow maize late, the harvesting time of maize overlaps with the sowing time of legumes. Farmers have to follow a relay cropping system, so they have to sow legume seeds before harvesting the maize and they sow the legumes manually while the maize crop is still standing in the field. If they delay until the harvesting of the maize and then sow by plough, they will suffer a loss in yield of legumes.

b. Because of the reduced monsoon season and earlier commencement of the drought, the production of these legumes has been drastically reduced, in some years even up to 100 per cent.

- Maize yields have been reduced drastically due to droughts. People then feed the maize stalks to their cattle without having a harvest.
- Late sowing of maize also impacts on the timely planting of tomato as the relay crop. (Tomato has turned out to be a good cash crop for farmers because of the increased access to markets that was enabled recently.)
- Improved, imported and hybrid seeds have not advanced the situation compared to the existing local varieties. Yields from local varieties have still declined while new varieties failed completely.

B. Prolonged winter drought

Winter rain has been sparse in recent years. People remember when there used to be winter rain (called *puse jhari*) that lasted for at least one week, and which is crucial for land preparation for the next season after the harvest of the grain legumes.

- Thus, the land could not be properly ploughed and exposed to drying by the sun before sowing. Moreover, this has also increased the incidence of soil-borne diseases, which led to wilting and rotting of the maize stalks and roots as well as to an increased population of insects (borer, white grub and termites) in recent years.
- Because of the prolonged drought season and augmented days of downpours, the problems of landslide and soil erosion emerged. The conservation of soil fertility and nutrition has become a significant challenge in this respect.
- The drying of water sources cannot only be attributed to the fewer and infrequent days of rain (the rainy period used to be June 15 - September 30, but now it lasts from July 15 to August 30), but also to uncontrolled infrastructure construction (e.g., road building) and the reduction of forest areas.

C. Drying up of water sources

The major sources of water in the study sites are small streams and springs. Water from springs is used, *inter alia*, for drinking, watering livestock and growing its fodder, and irrigation. In recent years, due to the prolonged winter drought, reduced frequency in rainfall, decreased water infiltration capacity of soils, forest degradation, and infrastructural construction, the traditional water sources have dried up for extended periods of the year. This process has the following effects:

- Low hill rice cropping patterns have been converted into maize-rice cropping patterns. Due to the lack of water, farmers are not able to grow summer rice anymore.
- The growing shortage of drinking water for animals has been identified as a further constraint.

- Even land that used to be irrigated before is gradually being converting to rainfed areas because of the drying up of springs. That is why farmers have started to grow different cash crops, including vegetables, which use less water than rice grown on the same land.

3.4.4 Increased frequency of extreme weather events

People have experienced an increased frequency of drought events, downpours, and hailstorms in recent years. For example, people in Jogimara lost up to 80 per cent of their maize crops for the three years prior to last year (2010) due to hailstorms. Likewise, they also lost about 90 per cent of the total production of mandarin oranges, which are the only cash crop in the area for the same cultivation period

3.4.5 Effects on the livestock system

- People recognized that there has been an increased problem with animal sterility in recent years. There had been clear animal breeding seasons previously but these are now subject to irregularity. The later births of animals create serious problems for farmers since they do not have enough fresh forage and fodder to feed the animals in the critical birthing period, which results in a significant decrease in milk production for the whole lactation period.
- Early sprouting of fodders and fruits has also become a problem because fodder matures quickly and is therefore less palatable at the time when it is needed.

3.5 Other significant recent changes in the farming system not directly attributed to climate change

Some changes in the system cannot directly be attributed to the altering climate; however, there is an indirect influence through the general impacts climate patterns have on the whole farming system.

- A huge decrease in the production of grain legumes has been perceived. Alongside the change in rainfall patterns, other factors (e.g., increased access to markets) have forced people to grow fresh vegetables.
- A strong trend of out-migration has developed, which creates labour scarcity for farming activities.
- Another emerging trend is related to an increase of land leasing and renting. People prefer to grow cash crops and vegetables (instead of cereals) on leased and rented land.
- Farmers are convinced that traditional local crop varieties produce less than the improved ones – however, the former are better adapted to climatic variability. Since people prefer higher yields as opposed to adaptive capacity, many local varieties have already been lost, and remaining ones will probably disappear in the future.
- People were very much dependent on farmer-to-farmer extension services. In recent years they have also been provided with such services by certain NGOs and the DADO. However, this system is not fully functional yet. One farmer in Jogimara, for instance, reported that he has been using the same maize variety for 32 years, which indicates that a lack of access to extension services still exists.

3.6 Climate change as a contributing factor to overall changes

Although most of these changes are attributed to climatic patterns, many further socioeconomic changes have huge impacts as well. Some of these are listed below:

1. Change in farming systems and livelihood options:
    - Millet used to be the major crop relaying maize, and thus the staple food in the region during the last 20 years. But it has been increasingly replaced by cash crops like vegetables and grain legumes.
    - Also, the consumption of millet was drastically reduced and substituted with rice purchased from nearby markets. This is ascribed to the improved access to transportation and markets in recent years. Thus it can be observed that farmers are moving away from their subsistence way of farming.
2. Increased access to market:
    - Both VDCs are able to benefit from newly-built dirt seasonal roads that are used to transport cash products (e.g., milk and vegetables) to the market and to transport back rice and other staple foods bought from the market.
3. Increased trend of out-migration:
    - The increase in the rate of out-migration and foreign employment is significant. About 27 young people from 110 households in Salang, and 20 young people from 67 households in Jogimara, were outside the country during the study investigations. Most of them had gone to the Middle East or Southeast Asian countries to engage in cheap labour work.
    - Due to the out-migration of the young, male agricultural labour force, the burden of agricultural work has been transferred to either old people or women. Nevertheless, this migration trend is inducing a huge labour shortage during the peak periods of sowing and harvesting of the major crops and is also expected to decrease the overall productivity of the agricultural sector.
4. Deceased trend in livestock rearing. The reduction in livestock rearing has been an effect of climatic as well as many socioeconomic factors, which are elaborated below:
    - Replacement of the local cattle breeds by exotic ones increased milk production over time. Now farmers are able to produce increased amounts of milk with fewer cattle of exotic breeds, hence they have reduced the number of the cattle they keep overall. In addition to this, the improved breeds need more inputs than the local cattle – another reason why farmers now keep smaller herds.
    - After initiating the community forest user group (CFUG) as a protective forest management system, the livestock growers started to find it difficult to get enough pasture land – as well as enough fodder and forage – since it had been a common practice to take them from the forest. As a result, farmers had to cut down the number of free-grazing livestock they kept.
    - Until about 4 - 5 years ago, Nepal used to have so-called ‘milk holidays’ – a special practice in the peak milk production period of the year when the dairy development corporation and other private dairies declared ‘holidays’ on certain days of the week during which they did not collect milk. That practice discouraged the investment in milking animals, impacting on the numbers kept.

Anything listed above may explain the reason behind the reduction in numbers of livestock, but this creates specific consequences for the farming system, which are presented below:

- A reduced number of livestock animals means a reduction in the amount of farmyard manure (FYM). This has already resulted in a decline in the organic matter in the soil and thus a deterioration in soil health. The reduction of soil organic carbon reduces the water-holding capacity of the soil. Taking the existing drought problem into account, the deterioration of soil quality will be intensified.

- To supplement the reduction of soil nutrients, farmers have increased the use of chemical fertilizers, which has also resulted in soil deterioration and the reduction of water-holding capacity.

5. Enforcement of laws on agricultural inputs is weak. Farmers contend that the enforcement of laws and regulations regarding quality control of agricultural inputs (e.g., seeds and fertilizer) has been weakened because of political instability, which eventually affects the quality and price of the outputs.

6. Increased environmental degradation:

    - Huge problems of environmental degradation have been caused by increased use of chemical pesticides and insecticides for commercial farming, uncontrolled infrastructural construction, and deforestation. These developments have intensified the difficulties caused by changes in precipitation, drying up of water sources, warming up of the environment, and soil and water degradation.

4. Planning for adaptation

The planning of community adaptation was done by generating an adaptation pathway and identifying adaptation signatures. Most of the possible adaptation actions were identified during the CRISTAL exercise in the communities. The possible solutions to climate change effects as suggested by the thematic experts were combined with those of the farming communities. Based on the identified options, communities were encouraged to evaluate what the ideal components or structures in their system would be if they were aiming at making the system optimally resilient within 20 years. Based on these components and structures, the pathways through which the communities can potentially reach the stage of resilience were generated. The major activities (or groups of activities) that were identified for implementation between now and 2031 were identified as the adaptation signatures.

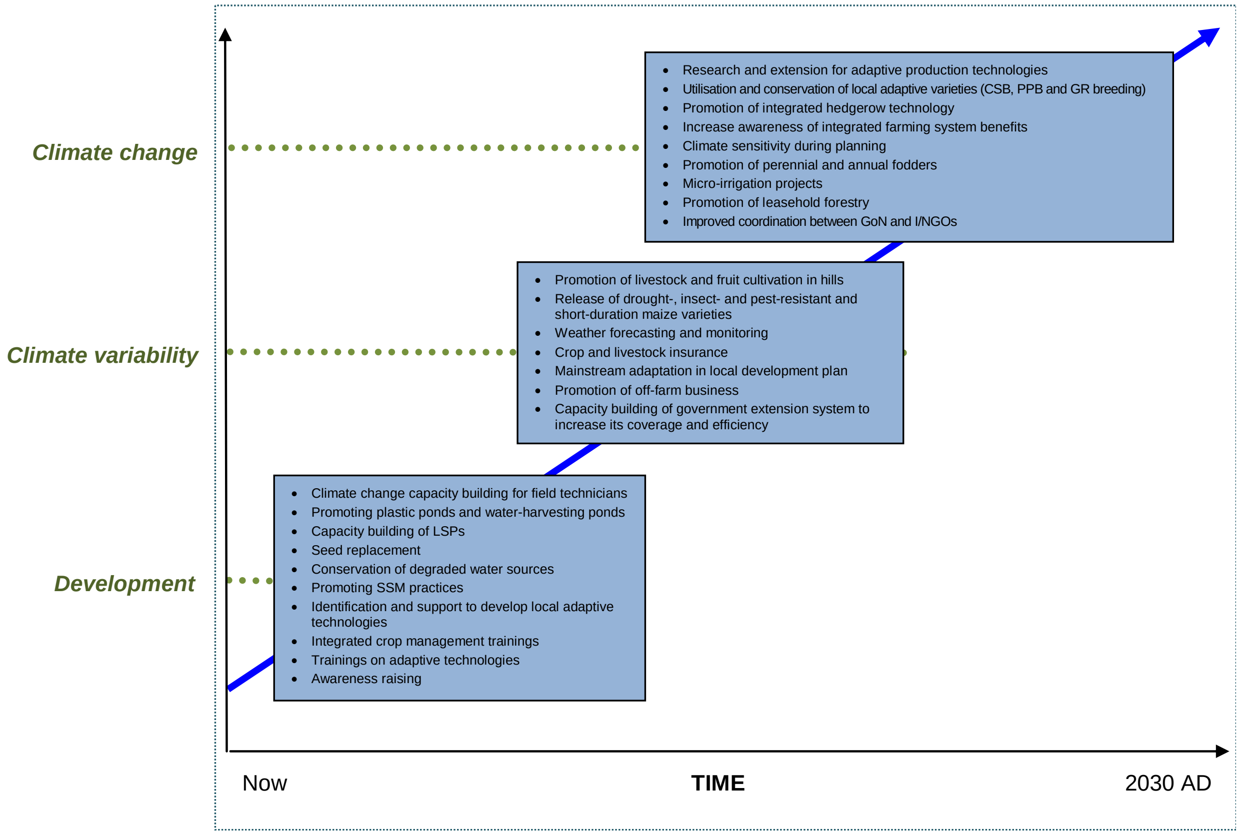
4.1 Adaptation pathway and signatures

The adaptation pathway (see Figure 10) was developed in mutual collaboration with communities and a diverse group of stakeholders.

One of the outcomes of creating the adaptation pathway was that adaptation actions in the agricultural sector should build on programmes and activities that are already part of sectoral plans. This underlines the fact that agricultural adaptation should not be conducted via a project approach; actions should instead be integrated in national plans for ensuring the gradual improvement of adaptive capacities. Although most of the adaptation signatures have already been part of the national plan, high additional costs will be incurred to scale-up these activities.

The adaptation priorities for the hill farming system include improving practices for integrated soil and water management, and strengthening adaptive research and the extension system. This includes the identification and transfer of respective adaptive technologies – predominantly regarding varieties, farming practices, harvesting, and rain water usage. In fact, the integrative character of the farming system itself can be seen as an adaptation strategy already, as long as it is implemented in the correct way. Thus, actions like promoting capacity building of local service providers, sustainable soil management (SSM) practices, water harvesting plastic ponds, as well as the conservation of degraded water resources, have been identified as the major adaptation signatures.

Figure 10: Adaptation pathway of Jogimara and Salang.



Note: LSP = local service providers; SSM = sustainable soil management; CSB = community seed bank; PPB = participatory plant breeding; and GR = grassroots.

4.1.1 Descriptions of the adaptation signatures

The signatures have been categorised into two broad groups. The first group refers to the signatures which are closely linked to the need to address climate change and its impacts. The other group is related to the overall agricultural development programme. The distinction between these two is not, however, explicitly clear since the overall agricultural development agenda also contributes to the increased adaptive capacity of farmers. For the purposes of this analysis, any signatures that are already reflected in the agricultural development plan of Nepal, or are recognized for future considerations, fell under the regular agriculture development programme, whereas the remaining signatures were linked to climate change adaptation specifically.

A. Signatures specifically related to climate change response:

Immediate signatures
Capacity-building activities of local technicians and field workers in the extension of agriculture, livestock, forest, soil conservation, watershed management, health and infrastructure development emerged as an immediate need to be mainstreamed into the LAPA. Such actions need to be conducted by local service providers from the public as well as from the private sector.

The varieties of the major crops (maize, rice and pulses) that are better adapted to the short rainfall period, late sowing conditions, and increased heat need to be further explored. Some of the maize varieties that are claimed to be drought-resistant – for instance varieties like Rampur Composite (released over 30 years ago), Manakamana 3 (eight years ago), Mankamana 4 (two years), Sitala (<5 years), Deuti (<5 years), Posilo Makai (latest) – were recommended to the farmers but they identified the need for local adaptive trials for those varieties in their own locality.

The technologies for managing water scarcity, such as the conservation of water sources and the promotion of water harvesting measures (for instance through plastic ponds and rainwater harvesting ponds) were also identified as immediate adaptation responses to climate change.

Finally, the promotion of hedgerow technology for controlling the loss of fertile soils caused by downpours in recent years should also be implemented in the immediate term.

Medium-term signatures

Since the opportunities to benefit from adaptive varieties are very limited at the moment, their further development through research and extension should be prioritised. This would also respond to farmers' needs for solving the current challenges of changing cultivation periods, water scarcity, and extreme events. Farmers claimed that many local varieties are more adaptive to climate change than new ones – hence the conservation, validation, as well as utilisation of the promising local varieties and landraces through the establishment of community seed banks and participatory, as well as grassroots, breeding should be conducted.

The integrated farming system itself already provides certain resilience, but it was witnessed that the system is gradually disintegrated. Consequently, increasing awareness and understanding of the benefits of the integrated farming system in the context of climate change adaptation was identified to be an additional adaptation signature.

Long-term signatures

Promoting livestock and fruit cultivation in hills were identified long-term adaptation signatures. They contribute to the integrated farming system by making it more resilient. Likewise, the development and release of the drought-, insect-, and pest-resistant, as well as short duration, maize varieties was identified as a crucial signature for strengthening the system.

Additionally, the establishment of weather forecasting and monitoring systems has become a long-term requirement as well. As a defensive protection measure, the necessity for crop and livestock insurances was recognized as another possible signature. In order to achieve sustainability in the long term, these activities have to exceed the community project-level, and must be mainstreamed in the LAPA.

B. Survival options, development and efficiency improvements:

Many agricultural development actions were also identified as vital signatures for the adaptation to climate change. It was recognized that it is impossible to detach the adaptation signatures based on the farmers' survival options from the immediate or long-term development plan for the agricultural sector.

Immediate signatures

The replacement of the major crop seeds with more adaptive varieties, better suited to the climate conditions, is a primary necessity for local people and thus should be implemented as a continuous activity in the national development plan. It was witnessed that farmers have been using very old varieties without changing the seeds for a long time, which led to a decline in productivity and adaptive capacity. Another identified adaptation signature is the provision of integrated crop management trainings.

Signatures that are already included in local development plans are: water conservation of degraded water sources and SSM practices. The latter refers, *inter alia*, to promoting terracing, shed improvement, soil nutrient management and judicious use of organic manure.

Medium-term signatures

Further synergies among adaptation signatures and overall development plans in the medium-term were the promotion of perennial and annual fodders in the terraces of the hills and the forest management system. Additionally, more efficient water management practices – such as micro-irrigation technologies – should be implemented.

From a governance aspect, the coordination among governmental organisations (GOs) and international/non-governmental organisations (I/NGOs) working in agriculture and natural resource management requires improvement. Although local animal breeds are resistant to environmental changes, it was detected that they produce less and thus warrant adaptation measures as well.

Long-term signatures

In the long term, while considering the changing socioeconomic dynamics, creating more opportunities for people to get engaged in agro-based off-farm businesses should be promoted as an adaptation signature. Due to the limited capacities of the government extension agencies like DADO, agricultural service centres (ASCs), district soil conservation offices (DSCOs) and district livestock service offices (DLSOs), the implementation of the agricultural adaptation programme was constrained. Despite having initiated supportive agricultural development actions that enhance the adaptive capacity of farmers (such as promoting SSM practices), governmental endorsement is still negligible. Thus another important adaptation signature identified in the study is to advance the capacities of the governmental extension system for increasing coverage and efficiency.

Agricultural laws and policies lack sufficient enforcement since farmers realized that the quality control system of the major agricultural inputs (e.g., seeds, fertilizers and agro-chemicals) is not effective. So developing functional mechanisms to enforce the laws and regulations was also considered a long-term adaptation measure.

5. Cost of adaptation signatures

The costing of adaptation to climate change was done by calculating the possible implementation costs of the adaptation signatures in the communities. The costing was allocated to different categories of signatures and different levels of implementation, which are discussed in the following subsections.

5.1 Costing at different levels (household, community, district and national)

The total budget needed to implement the identified adaptation signatures in communities was estimated through participatory project budgeting. Several assumptions regarding prices, wages, time, interests, and additional cost factors were made to estimate the budget needed for the implementation of the adaptation pathway. Based on the overly high number of influencing externalities behind the cost estimation; the limited scope and geographical coverage of the study; as well as the static nature of the estimation, the stakeholder workshop revealed that the total amount of costs estimated for the national level has insignificant meaning. The workshop results also suggested the need to be prudent in applying the cost estimation done at the district level since the possibility of miscalculation is still considered to be high. The same caution is applied to the generalisation of the community-level costs, since they may also vary by the localities, as well as by social and economic factors.

The overall findings of the cost estimation at the different levels of agricultural extension are as follows:

A. Costs at household level

The cost at household level has been gathered through a household survey of 60 randomly-sampled households from the study sites. Table 5 shows a) the total expenditure of the 60 households for different activities and investments for adaptation and/or coping with increased climatic variability; and b) total expenditure that they would like to invest for increasing the resilience of their agriculture to future climatic hazards.

The table shows that, on average, about NRs.16,083 (≅ US$215) has already been invested per household in adapting to the negative effects of climatic changes. A major part of this sum has been spent on activities for adapting drought situations (62 per cent); controlling insects and pests (20 per cent) and adapting to landslides (17 per cent) are other key expenditures. An average about NRs.89,858 (≅ US$1,200) has been predicted per household for investing in climate change activities into the future. This expected expenditure breaks down to: 34 per cent for adaptation to drought; 32 per cent for adaptation to reduced winter rainfall; 16 per cent for adaptation related to landslides; 9 per cent for adaptation to increased incidences of diseases and pests; and 8 per cent for adaptation to increased temperature.

Table 5: Prior expenditure and expected expenditure of households for agriculture adaptation to climate change (NRs) (Note - 1 US$ = 75 NRs.)

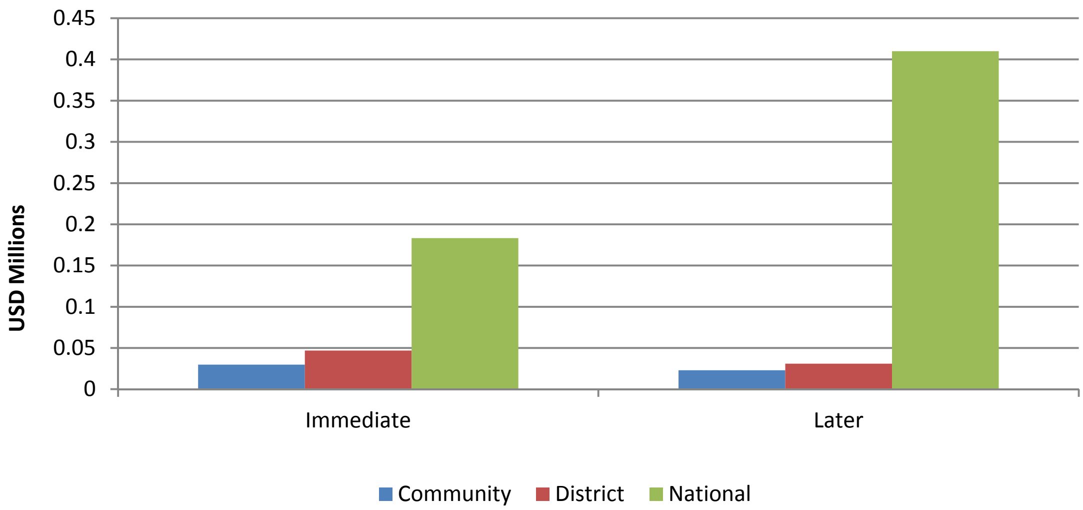
S.N.	Adaptation measures	Drought		Winter rain		Temperature increment		Landslide		Increased disease and pest			
		SE*	EE	SE	EE	SE	EE	SE	EE	SE	EE	TSE	TEE
1	Tree plantation	40,000 (2)	41,000 (8)				173,000 (24)	120,000 (8)	212500 (34)			160,000	426,500
2	Water resource conservation	500,000 (1)	85,000 (5)		257,000 (20)							500,000	342,000
3	Rainwater harvesting	25,000 (2)	284,000 (14)		647,000 (32)							25,000	931,000
4	Water supply through pump	3,000 (1)	225,000 (8)		36,000 (3)							3,000	261,000
5	Drought-resistant varieties	10,000 (1)	90,500 (15)				206,000 (10)					10,000	296,500
6	Plastic pond		736,000 (35)		235,000 (12)								971,000
7	Drip irrigation				135,000 (11)								135,000
9	Quality seed use		51,000 (9)		3,000 (3)		6,000 (4)				10,000 (2)		70,000
10	Fodder tree plantation		195,000 (16)		107,000 (15)			10,000 (1)	295,000 (20)			10,000	597,000
11	Pipe irrigation	25,000 (2)	145,000 (8)		145,000 (8)							25,000	290,000
12	Waste water management				41,000 (4)								41,000
13	Pine				75,000 (3)								75,000
16	Promote insect pest-resistant varieties										80,000 (7)		80,000
17	Integrate hedgerow technology								143,000 (16)				143,000
18	Fencing							41,000 (10)	196,000 (11)			41,000	196,000
19	Integrated pest management						30,000 (3)			12,000 (3)	257,000 (15)	12,000	287,000
21	Adaptive technologies				51,000 (5)		40,000 (4)				90,000 (5)		181,000
22	Use of bio-pesticides									33,200 (5)	30,000 (11)	33,200	30,000
23	Use of chemical pesticides									145,800 (17)	38,500 (12)	145,800	38,500
	Total	603,000	1,852,500		1,732,000		455,000	171,000	846,500	191,000	505,500	965,000	5,391,500
		10,050 (62%)	30,875 (34%)	(0%)	28,867 (32%)	(0%)	7,583 (8%)	2,850 (17%)	14,108 (16%)	3,183 (20%)	8,425 (9%)	16,083 (100%)	89,858 (100%)

Note: SE = Expenditure to date; EE =Expected expenditure for adaptations to climate change; TSE = Total expenditure of households to date; TEE = Total expected expenditure of households for climate change adaptation.

B. Costs to communities

About 600 households from two villages were included in the calculation. It was estimated that the villages would each need at least US$40,000 annually to implement the identified immediate adaptation signatures for the next eight years.[3] At least a further US$16,000 annually is projected for implementing the identified long-term signatures. These costs do not cover the costs that should be borne by the households to adopt the adaptation activities.

Figure 11: Costs at different levels of agricultural extension.



C. Costs to districts line agencies

The assumption for calculating the costs at the district level was that at least 40 villages of comparative size would implement similar adaptation plans, while district line agencies would be responsible for coordination and technical support. It was estimated that at least a US$46,000 annual budget is needed to implement the immediate signatures for the next eight years, and at least a US$31,000 annual budget for the following 12 years. These costs do not include the signatures for building coordination among the service providers and strengthening the capacity of the extension system.

D. Costs at the national level

Assuming a scale of at least 20 districts that will implement the adaptation plan in at least 40 villages, the costs at the national level to facilitate and coordinate the adaptation actions was also computed. It was estimated that at least US$183,246 annually for the first eight years, and at least US$409,896 annually for the following 12 years is needed to facilitate and coordinate the adaptation actions. This does not include the costs of major adjustments and capacity building of the national extension system, and structural improvements in the institutions for research and extension.

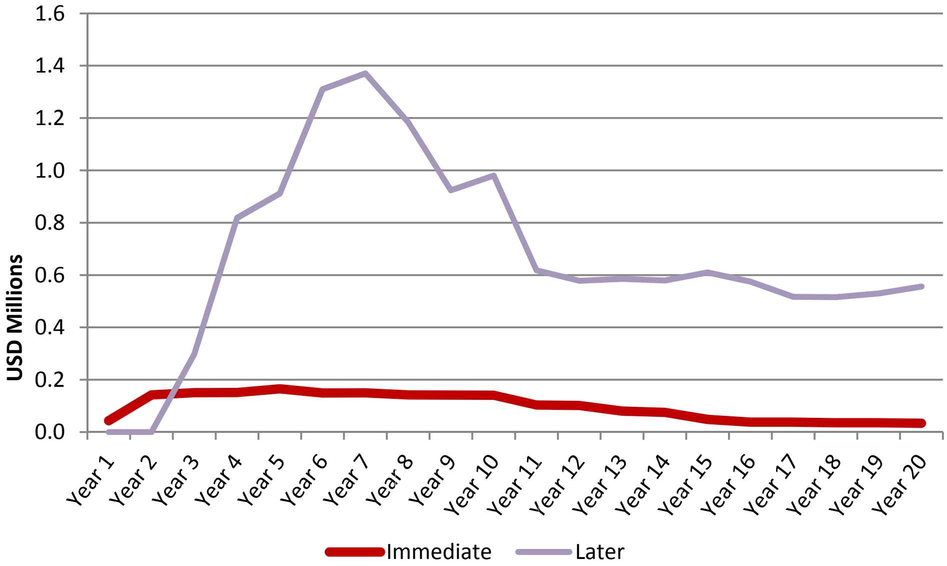
5.2 Costs of immediate and long-term signatures

The costs of implementing immediate and long-term signatures is analysed in separate distributions (see Figure 12). Immediate signatures are characterised as those where a major part of the costs is incurred during the next eight years, whereas long-term signatures will incur their major costs after eight years.

[3] The initial calculation was based on Nepalese rupees. For conversion: 1 x US$ = 74 NRs.

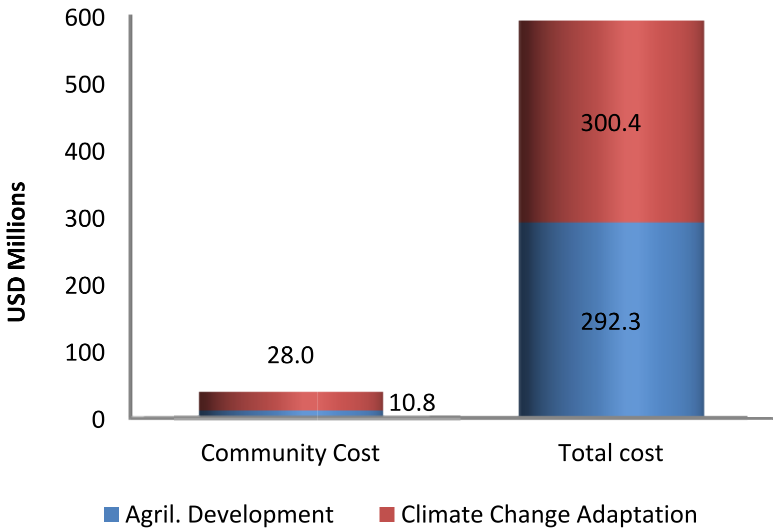
The figure shows that the costs of immediate signatures gradually increases for 3 - 4 years and then declines again. Even if the major costs of these signatures are indeed incurred during the initial years, some costs will remain for following up and continuation of the actions in the long term. These costs should be implemented through national programmes of the government and an institutional framework should be established that enables better accommodation of the community costs.

Figure 12: Distribution of costs for implementing immediate and long term signatures.



5.3 Distribution of costs for agricultural development (and in particular for adaptation)

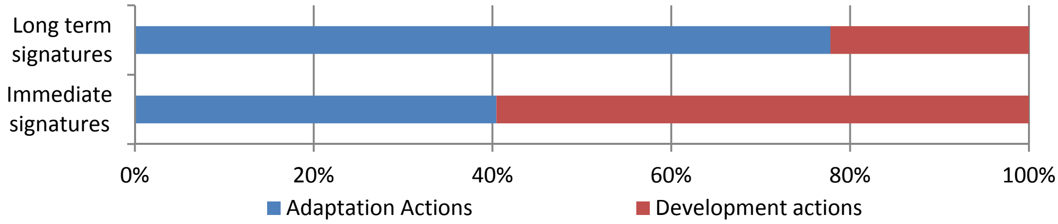
Figure 13: Distribution of signature costs for agricultural development and climate change adaptation.



The adaptation signatures that have already been included in the national agricultural development plan and policies are categorised as agriculture development actions. On the other hand, the signatures that particularly relate to climate change adaptation are classified as 'adaptation actions' in the analysis. Although the distinction is not necessarily always clear, the analysis shows that the costs of implementing the signatures identified for sustainable development of the agricultural sector and the costs of signatures identified particularly for climate change adaptation are about equal. Interestingly, the evaluation revealed that about 72 per cent of the total costs of implementing the adaptation signatures in communities happen to be the costs of implementing specific activities for climate change adaptation (Figure 13).

The analysis also showed that many of the immediate action costs happened to be the costs of implementing the sustainable agriculture development programmes; on the other hand, the costs for adaptation signatures emerged in the long term (Figure 14).

Figure 14: Immediate and long-term costs for agricultural development and climate change adaptation.



5.4 Implications drawn from costing of the adaptation signatures

1. It was found that about half of the costs required for the implementation of the adaptation signatures go towards the measures that are already mainstreamed (or are in the process of being mainstreamed) in the regular agricultural development programme. As these signatures provide important options for climate change adaptation as well, the extra costs incurred to expand the coverage and effectiveness of these development actions are regarded as the costs of adaptation to climate change.

2. Most of the signatures identified in the adaptation pathway are no-regret development measures[4] and soft technologies, which should always be given priority since many existing technologies and processes are already capable of increasing adaptive capacities, whereas the development of new technologies should be part of the long-term development agenda.

3. The immediate signatures are specifically related to the regions, whereas long-term measures are applicable to the whole system. To implement the long-term adaptation signatures effectively, their mainstreaming in regular development plans is essential.

4. Capacity building in the line agencies and the service delivery mechanism was identified as an adaptation signature in the study; it was difficult to cost the structural change in the service delivery mechanism however. Thus the strategy should be integrated in the agricultural development plan rather than being a signature for climate change adaptation.

[4] Adaptation measures that would be justified under all plausible future scenarios, including the condition of 'no effects of climate change'.

5. After generalising the costs at the district and national levels, it was realized that the study employs many assumptions for costing (i.e., minimum numbers of households in a VDC adopting certain technology; minimum number of VDCs planning and implementing the adaptation pathway; the static nature of the relationship among the variables of costing; and uncertainties regarding future changes). These assumptions and uncertainties are believed to affect the accuracy of the estimations in the process.

6. The high costs for adopting the new technologies and further changes, which are excluded from the general costing of agricultural adaptation measures, will still burden farming households. Since the costs of adaptation at the household level are difficult to estimate, more dynamic methods for the cost modelling are needed.

7. The integrated hill farming system itself already enhances adaptive capacities and also creates synergies with mitigation efforts.

5.5 Distribution of costs for adaptation among different stakeholders

For implementing the adaptation actions it was found that the involvement of all stakeholders – from the local-level farmers' groups up to the national level – is equally important for progress. As district- and community-level stakeholders are directly involved in service delivery, their role is critical. Likewise, with its pursued decentralised policy, the GoN (and thus the role of the VDC and DDC) also has a significant impact.

The adaptation actions can easily be divided into different levels. It was found that plans for immediate action tend to prioritise general agricultural development programmes, which predominantly focus on the community level. Some of the signatures, e.g., strengthening the coordination with other partners, lie at the district level; activities that are related to formulating policies, plans and strategies (as well as conducting long-term adaptive research) are believed to be more time-consuming and should be implemented at the national level. Community-level activities are very specific to the integrated hill farming system, while the actions at the district and national level are more generic and cover other systems as well.

The capacities of the line agencies and institutions at district and VDC level were found to be limited for providing sufficient services to the farming communities. While government policy is moving towards decreasing the number of ASCs and involving more private sector service providers, it appears to be challenging to replace the currently extensive coverage of ASCs.

Although we have been talking about adaptation, some of the adaptation signatures identified in the study, such as the promotion of the integrated farming system, hedgerow technology, and controlling deforestation, also contribute to the mitigation of carbon emissions and to carbon sequestration.

6. Institutional and policy analysis for agricultural adaptation in Nepal

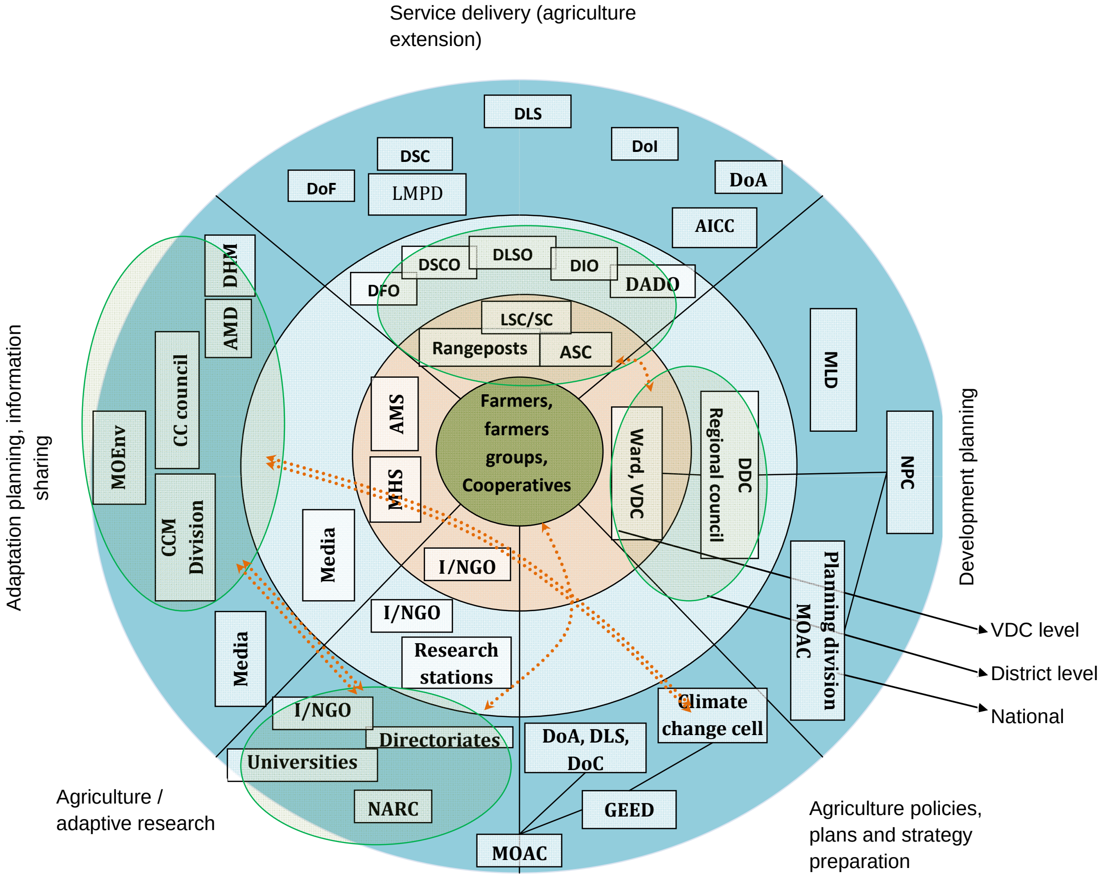
6.1 Institutional analysis

In terms of the adaptation to climate change in agriculture, three ministries were identified as the crucial institutions:

The **Ministry of Environment** (MoEnv) is the focal ministry for all climate change-related conventions and protocols that Nepal has signed. The MoEnv provides the Secretariat for the Climate Change Council and the Climate Change Coordination Committee. Within the ministry, a division is in charge of the following management tasks:

- Formulating climate change policies and programmes.
- Conducting policy research.
- Developing the national position for climate change negotiations.
- Formulating and implementing the National Adaptation Programme of Action (NAPA) and coordinating mitigation activities.
- Outsourcing the technical and financial resources for climate change adaptation.

Figure 15: Institutions for climate change adaptation in agriculture.



Note: See the 'Acronyms and abbreviations' section at the beginning of this study for explanations for these acronyms.

The most relevant institutions of the **Ministry of Agriculture and Cooperatives** (MOAC) for climate change adaptation are: the Department of Agriculture (DoA), the National Agriculture Research Council (NARC), the Seed Quality Control Centre (SQCC) and the National Seed Company Limited (NSC). NARC is an autonomous body for agricultural research that was established in 1991. Within NARC there is the National Agricultural Research Institute (NARI) and the National Animal Science Research Institute (NASRI). There are 75 DADOs, one in each district across the country. They are responsible for planning and implementing agricultural development activities and are expected to maintain active linkages with agricultural research stations and other stakeholders, including NGOs and private sector organisations. One of the major problems within the system is that there are long routes between research and farmers, research and education, and research and extension.

The **Ministry of Local Development** (MLD) is responsible for the planning and implementation of activities at the local level. This ministry targets strengthening local capacity building through improving the planning, implementation and evaluation procedures required for any development actions, including adaptation projects.

The responsible institutions vary according to governance level and respective development themes (e.g., development planning, agricultural extension and service delivery, climate change adaptation planning and information sharing, agricultural research and setting of agricultural policies) as well as plans and strategies (see Figure 15). Based on the analysis of the previous chapters, the major constraints for climate change adaptation in Nepal's institutional setup are summarised as follows:

- The weak linkages among agricultural research, extension, education and climate information systems. In order to trigger the needed expansion of agricultural research for adaptation in terms of suitable crop varieties and other technologies, building close collaborations among these institutions is essential.
- There may emerge a conflict and duplication of roles among the different institutions regarding the implementation of adaptation programmes. The lack of coordination between the MoEnv and MOAC, particularly concerning their respective cells for climate change issues, hinders the process of mainstreaming climate change adaptation in the agricultural development plans of Nepal. The hierarchical structures and the limited coordination between the MoEnv and the agricultural service providers, which also occurs at the district level and between the VDCs and VDC Council, likewise create difficulties for the effective mainstreaming of adaptation.

Apart from the institutional challenges, the study has also identified other gaps that hinder the integration of adaptation in agricultural development plans:

- The limited capabilities of the agricultural service delivery agencies (e.g., DADOs and ASCs) constrain the extension services provided to the farmers. It was evident from the data of the Dhading DADO that it has reached only 18 per cent of the farming households in the district (and the government agricultural extension service has only reached less than 20 per cent as well). This similarly applies to the extension of livestock, forest and soil conservation services. As one of the major aspects discussed during the stakeholder workshop, the promotion of a 'farmer-to-farmer' extension system was identified as a potential solution to this problem.
- The government intends to accelerate the involvement of the private sector for meeting extension targets and thereby reduce the number of ASCs. But it should be noted that private sector investment and participation in the agriculture extension system has not yet been observed to match that anticipated by the government. Secondly, the weak coordination of the activities conducted by the private sector (including I/NGOs) has led to fragmented results rather than holistic development and inclusive changes.

- Due to the limited capacity of farmers and farmer groups, proactive efforts from service receivers to make the extension system more effective are almost non-existent. Thus the creation of well-structured farmers' institutions is required to complement the government extension system by making the service delivery more efficient.

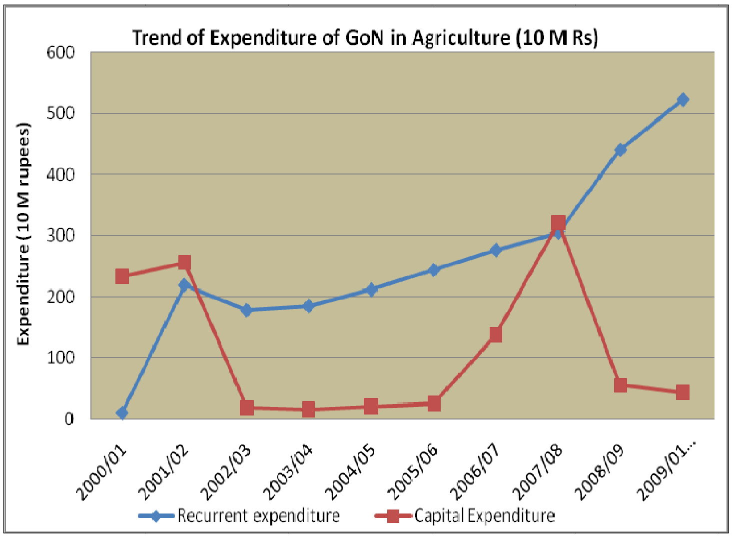
6.2 Current fund flow in agricultural development and climate change adaptation

A programme or project by the MOAC to fund climate change adaptation measures in the agricultural sector does not exist. Existing MOAC programmes related to adaptation include projects for soil and water conservation, sloping land management, technology transfer, and agronomic trainings. Most of the budget is allocated to the projects that focus on soil and water conservation.

6.2.1 Trends of government expenditure in related sectors

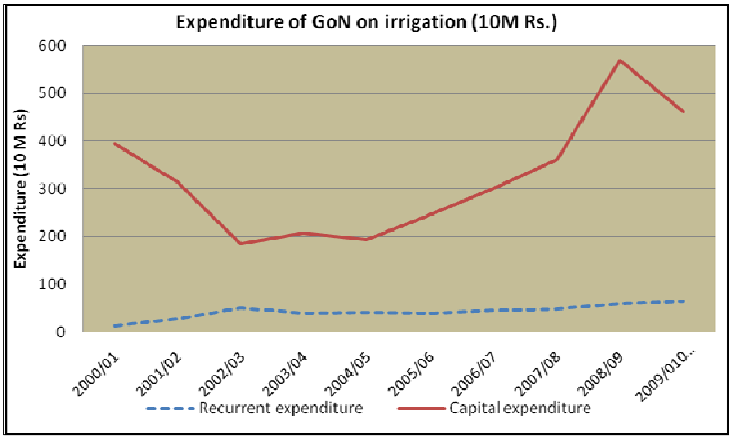
Although the recurrent expenditure of the GoN in the agricultural sector is increasing (Figure 16), the capital expenditure has sharply decreased recently. Thus the GoN has neglected the agricultural sector as compared to other sectors, which impedes the implementation of adaptation activities.

Figure 16: Trend of GoN expenditure in the in Nepalese agricultural sector (1 US$ ≅ 75 NRs) (Data source: NRB 2010).



On the other hand, the capital expenditure on irrigation projects (Figure 17) is increasing. These expenses are predominantly targeted at building large irrigation projects, however, instead of small and community-managed irrigation schemes.

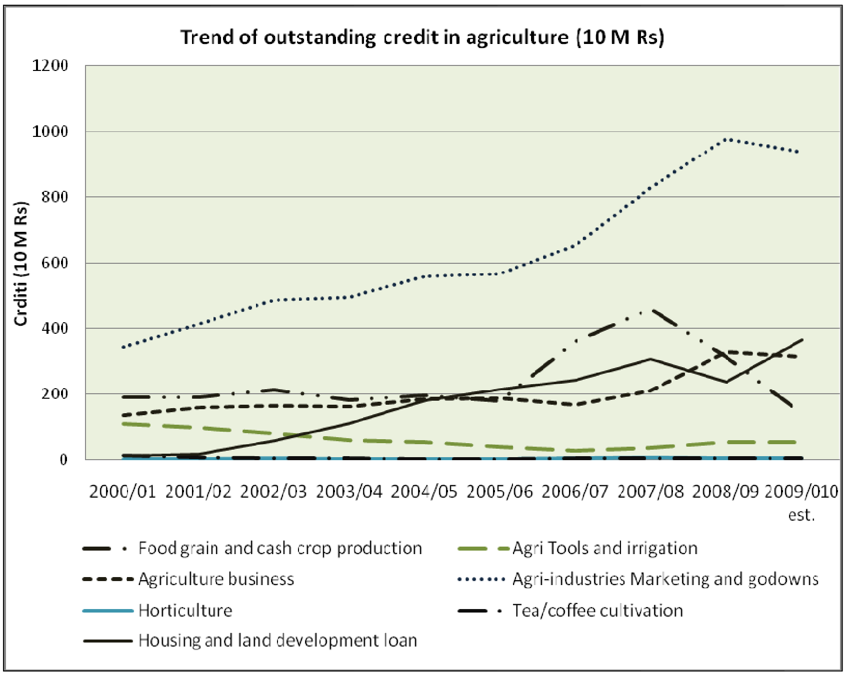
Figure 17: Expenditure of GoN on irrigation (Data source: NRB 2010).



6.2.2 Possibilities for private sector investment

The analysis shows that the current trend of credit flows in the agricultural sector is not very encouraging, except for investments in agri-industries, marketing and 'godowns'. Credits for cash crop production, agricultural business opportunities, and land development plans only increased gradually (Figure 18).

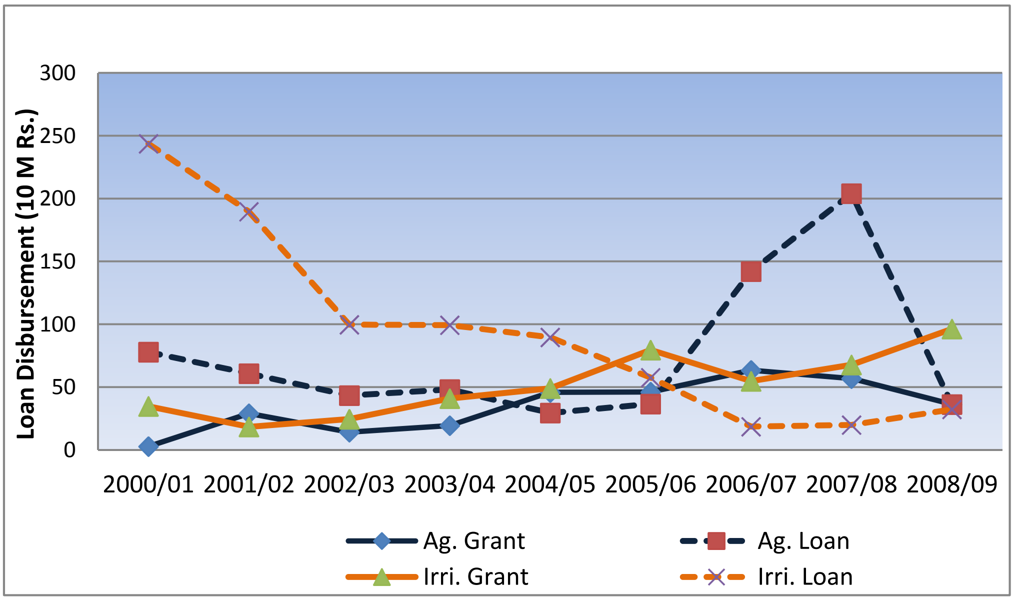
Figure 17: Trend of outstanding credit in agriculture (Data source: NRB 2010).



6.2.3 Trend of foreign aid in the agricultural sector

A subsector analysis of foreign aid in agriculture could not be undertaken due to the lack of concise and categorised datasets. There is a lack of a central accounting mechanism for all foreign aid flows; often aid funds used by NGOs do not appear in the national accounts. The governmental expenditure account shows that there has been a gradual increase in the grant disbursement for agriculture and irrigation, whereas there is sharp decrease in loans for both agriculture and irrigation (Figure 19).

Figure 19: Trend of disbursement of foreign aid in Nepal (Data source: NRB 2010).



In general, the provision of agricultural loans has been extensive between 2006 and 2008, and has become equal to the amount of irrigation loans.

6.2.4 Bilateral and multilateral donors

The sector-wide classification of foreign aid commitment for the FY 2008/09 reveals a share for agriculture, irrigation and forestry of 3.6 per cent, while the highest amount was allocated to local development with around 27 per cent (NRB 2010). Foreign aid disbursement in the FY 2008/09 on a sectoral basis shows that agriculture, irrigation and the forestry sectors received about 6.3 per cent of the total fund disbursement but agriculture was the only sector with a 40 per cent decrease in aid utilisation during the same period (NRB 2010).

Major donors for the agricultural sector – including the United Nations Development Programme (UNDP), the FAO, the Global Environment Facility (GEF), GTZ (German Development Cooperation, the former name of GIZ), the Department for International Development, UK (DFID), and Swiss Development Cooperation (SDC) – have worked on building capacities to implement multilateral environmental agreements and to support climate change adaptation in Nepal. Additionally, they have contributed to: food security, an increase in household incomes, improving productivity, and diversification of consumption.

The FAO in particular has stated that its priority will be to enhance the capacity for disaster risk management, prevention and preparedness as part of its climate change adaptation programme. The environment and climate change has emerged as a separate GTZ working theme in recent years, but agricultural adaptation has not received a special focus. GEF has historically been a major contributor for developing climate change strategies in Nepal, and this is expected to continue in its new Nepalese agenda.

Looking at the current developments and discussions, it seems that donor communities are interested in mainstreaming the adaptation process according to their own priorities for adaptive change.

6.3 Analysis of climate change and development policies

Since the 1980s, efforts have been made to integrate environmental concerns into national development plans and programmes. Nevertheless, climate change and environmental issues are still given inadequate priority in the national development agenda. Evaluations conducted under the national capacity needs self-assessment process in 2008 confirm that the nature and gravity of climate change risks are not fully appreciated. There is inadequate public pressure for change, and more pressing national agendas overshadow effective environmental protection and climate change risk management. Local governments are not provided with the opportunity to participate in climate change risk management and corresponding decision making.

The long-term orientated *Agriculture Perspective Plan (1997-2017)* (NPC 1997) has largely failed to achieve its intended periodic milestones so far, while neglecting the issue of climate change entirely. Likewise, *The Tenth Plan Poverty Reduction Strategy Paper 2002 - 2007* (NPC 2003) also targeted sustainable production increase and participatory management of natural resources as the major strategy for poverty alleviation.

The annual growth rate for the agricultural sector has averaged out at 2.67 per cent in recent times, in contrast to the targeted annual growth rate of 4.11 per cent, and one of the major indicated causes has been adverse climatic conditions (NPC 2007). Despite this, climate change was not identified as a future challenge for agricultural development in the NPC *Three Year Interim Plan*, covering the years 2007 - 2010; only extreme weather conditions (heavy rainfall and droughts) were identified as major risks for the anticipated agricultural production targets.

In 2010, the Climate Change Council endorsed the ***Climate Change Policy of 2011*** (MoEnv 2011), whose main goal is the mitigation of the negative effects of climate change through adopting a low-carbon-based social and economic development path. The policy also recognized that the Climate Change Council is responsible for coordinating all the activities related to climate change adaptation and mitigation, while the MoEnv will coordinate the implementation of the activities. Decisions on the following measures were facilitated: specific policies for adaptation to climate change and disaster risk reduction; building resilience; low carbon development; access and use of financial resources; capacity building; participation and empowerment; extension of research and studies; generation and transfer of technologies; and climate-sensitive natural resource management.

The building and enhancing of the adaptive capacity of vulnerable communities through improved institutional systems and access to agricultural services, as well as the promoting of community-based adaptation through integrated management of the agricultural, water, forest and biodiversity sectors, were prioritised in the ***National Adaptation Programme of Action*** (NAPA) document in 2010. Comparing the sectoral policies and plans for agricultural development within the NAPA and those of the *Climate Change Policy of 2011*, it becomes obvious that climate change has indeed become a crucial concern, but most policies still focus on improving productivity of major cereal crops and the commercialisation of agriculture, rather than building resilience in agricultural systems.

The National Agriculture Research Council (NARC 2010) recently issued its new 20-year strategic vision for agricultural research – *NARC's Strategic Vision for Agricultural Research (2011-2030)* – the major emphasis of which falls on mainstreaming climate change.

Although there is now clearly a growing inclusion of climate change issues in plans and policies recently enacted, many government policies and plans on the agricultural sector still do not take the anticipated climate change impacts into account and therefore need to be revised. Moreover, the budgetary allocation for agriculture needs to be increased by the GoN to enable better implementation of adaptation projects. Due to the devolution of the agricultural sector, the GoN plans to use the local fund (in VDCs and DDCs) for investments in agricultural development and climate change adaptation. This is, however, constrained by local political unwillingness. Despite recent policy shifts regarding the delivery of agricultural extension services through the private sector for reducing the number of service centres/sub-centres of the MOAC, the private sector has not provided the extent of services expected (NRB 2010). Reducing the number of ASCs is regarded as a retrograde policy because ASCs are the local bodies of the MOAC, providing essential services to the farming communities.

To facilitate necessary adaptation actions, current policies and strategies require transformation and inclusion in national development plans. Potential frameworks for implementing the agricultural adaptation projects were evaluated and, as stated in the *Climate Change Policy of 2011*, the 'single window system' will be pursued for managing the adaptation measures. In this context, the single window system has been defined as channelling all the adaptation assistances and supports through one institution/ministry (which will be, for practical purposes, the Ministry of Environment). But the weak coordination and lack of institutional structure of the MoEnv at district and VDC level creates difficulties for the MoEnv in implementing agricultural adaptation. So, if the agricultural adaptation actions are integrated into the planning of the MOAC, the allocation of funds for implementing the adaptation measures will be more flexible, based on the best possible cooperation and coordination with MoEnv. If adaptation planning at the local level were to start with the framework of the local adaptation plan of action (LAPA), it would automatically be reflected in VDC, DDC and national development plans. The identified actions incorporated in the national, district and VDC plans can be implemented by the respective line agencies (i.e., DADOs, ASCs and LSSCs).

6.4 Climate change information

1. **Availability of information**: there is a huge gap in the climate information needed for planning the adaptation activities effectively. Climatic data downscaled to specific locations and the prediction of future scenarios for the locations are very necessary for improved adaptation planning for the area. But such data and information are, for the most part, inaccessible to the local development planners.

2. **Sharing the information:** to understand and disseminate knowledge regarding the threats and adverse impacts of climate change, various stakeholders need to be included. By taking into consideration the experience of the Climate Change Network, the government has constituted the Multi-sectoral Climate Change Initiatives Coordination Committee (MCCICC), which will serve as the key national platform for ensuring regular dialogue and consultations on climate change-related policies, plans, finance, programmes/projects and activities.

   The MCCICC will establish and improve communication mechanisms among institutions concerned with (and working in the field of) climate change; coordinate climate change responses at programmatic level to foster synergies and avoid duplication of efforts; optimise benefits from existing programmes; coordinate activities related to policies, plans, strategies, financing programmes and projects; provide inputs for developing consensus on climate-related issues under international climate change negotiation; and provide inputs for financing in order to implement, monitor and evaluate the adaptation actions effectively, including those identified in the NAPA process.

3. The Ministry of Environment has also initiated the **Nepal Climate Change and Development Portal**, in which 57 different climate change projects are already

listed. The list includes projects supporting the government in planning and building climate resilience, as well as many disaster management projects supported by the Asian Development Bank (ADB), the Danish International Development Agency (Danida), the United Nations Development Programme – Bureau for Crisis Prevention and Recovery (UNDP-BCPR), the FAO and the World Bank. Some of the projects are related to the development of alternative energies that are promoted by the SDC, German Development Cooperation (GTZ) in Nepal, the European Union, the World Bank and the Norwegian embassy in Kathmandu. ADB, SDC and the Japan International Cooperation Agency (JICA), on the other hand, have supported projects for assisting government and local communities to build technical capacities and resilience through overall agricultural development. The list also contains programmes with explicit adaptation projects supported by DFID, the UN World Food Programme (WFP), the World Bank, Danida/Norwegian Embassy, the Development Fund – Norway, FAO and UNDP. These projects have been implemented by GOs and I/NGOs in different parts of the country.

6.5 Integration of climate change knowledge in current agriculture plans

Available climatic information has only been sparsely used in agricultural research. On the one hand there is a lack of information of a suitable quality, and researchers can be reluctant to use it when it is available. On the other hand, due to this shortcoming, climatic information is not updated, which impedes further climate change adaptation research. The situation is similar with planning activities. None of the current agricultural development plans (as well as the national periodic plan) used climatic information while they were formulated.

Photograph 4: Travelling seminar in Salang VDC (photo by B.B. Tamang, 26 March, 2011).

The local adaptation plan of action (LAPA) is a promising methodology for mainstreaming adaptation actions in development plans and policies. When the LAPA is incorporated into the VDC plan it may also directly affect the national level and be included in the national plan. Therefore stronger collaboration between the MoEnv and the respective line ministries is necessary.

7. Conclusions and policy messages

Climate change has brought about new challenges and constraints for agricultural development in Nepal. It will have serious implications on national food production, food security, and the livelihoods of poor and vulnerable people, particularly in rural areas. It is therefore expected to reduce economic growth and increase inequalities.

This study used a different approach towards planning for agricultural adaptation by integrating an adaptation pathway planning approach. The study also tried to estimate the costs for implementing the adaptation pathway by analysing its different cost implications. Similarly, the study assessed some of the policy and institutional constraints to implementing adaptation measures in agriculture, and evaluated the present state of climate change information available in the country in terms of transferring the available knowledge. Based on the findings of the study, the following policy messages for national as well as international policymakers were generated.

Policy messages:

1. Despite an existing information gap in scientific evidence regarding the effects of future changes in climate patterns and options for the future, the community-based adaptation process should nevertheless be initiated. This requires community involvement through participatory planning in order to make use of local experiences and knowledge.

2. The existing technologies at the community level, and among researchers supporting communities in undertaking adaptations to climate change, are currently inadequately disseminated. While the generation of additional technologies is regarded as a priority in the long term, transfer of already available technologies to the user community should be the immediate priority.

3. The local adaptation plan of action (LAPA) is an effective means to mainstream adaptation options in national and local governmental plans, and to support local communities in planning for adaptation. Although the initial costs of defining this methodology are high, they will decrease as soon as it is evolved and scaled up. Hence, the adaptation costs and resulting benefits will also remain at the local level.

4. The majority of the adaptation actions identified for the hill farming system in Nepal are long-term actions. In order to achieve sustainability, the adaptation actions should not be part of any project or one-time investment, but must be integrated into the regular agricultural development process.

5. Adaptation priorities for the hill farming system of Nepal mainly include improved practices for integrated soil, land, hedgerow and water management – for instance through water harvesting and small-scale irrigation measures.

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