Chapter 2

Community-Based Climate Change Adaptation for Building Local Resilience in the Himalayas

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1. Introduction

The Himalaya region has been experiencing the multitude of undesired change that cut across both biophysical and social realms. Observed biophysical changes include unpredictability in the timing and magnitude of rainfall, frequent occurrence of extreme heat during the summer season, glacial retreat and melting snow (Sharma et al. 2009; Gurung et al. 2010; MoE, 2010; Chaudhary et al. 2011). Temperature is rising over the past 100 years (Yao et al. 2006; Chapagain et al. 2009). These changes have already been posing serious threats on water, biodiversity, human health, agriculture, and consequently on food security throughout the region and downstream (Chaudhary and Bawa 2011). Vulnerable social and economic conditions pose further threat to the region. Recent social changes include rapid exodus of able-body manpower from the country, frequent economic crises, social and political unrest, and shrinking human capital. Since the region is the water tower of Asia and the lifeline for nearly one-fifth of world population, the current trend of climate change in the region will continue presenting an immense threat to humanity (Immerzeel et al. 2010). While any one of these factors will likely pose significant challenges on livelihoods of the people of the Himalaya region, the threat posed by changing climate and uncertainty associated with it cannot be ignored.

This paper (a) reviews an observed and perceived climate change in Nepal, (b) discusses impacts of climate change on ecosystems, biodiversity, agriculture and human wellbeing, and (c) offers, by drawing upon experiences of an NGO, Local Initiatives for Biodiversity, Research and Development (LI-BIRD), some community-based mitigation and adaptation techniques for curbing challenges resulting from climate change. The local level examples shared in this paper can be useful for other countries that share similar threats and socio-cultural and political challenges. People in other developing world can adopt the local technologies promoted by LI-BIRD in Nepal.

In the next section, we will provide background of Nepal, a Himalayan country that is sandwiched between two giants, India and China. Following that section, we present evidence of climate change, both observed and perceived, which is followed by impacts caused by climate change. Then we introduce an integrated climate adaptation model and some case studies drawn from LI-BIRD experience. Finally, we discuss the findings and provide some suggestions for the future.

2. Background

Nepal is a landlocked Himalayan country situated in between two economically booming giant countries, India and China. The country is characterized by geographical, ecological, and social diversity that give rise to wealth of biological diversity throughout the country. Not only eight of ten tallest mountains of the world are in Nepal, but there are more than 240 mountain peaks over 6000masl in the country. The country is facing tremendous pressure in its ecology and biodiversity resulting from social, economic and climate change, which is eventually affecting local livelihoods and wellbeing of people. People living in remote hills and mountains have limited ability to cope with changes and thus are under great threat.

Nepal has three physiographic zones (mountain, hill, and Terai) and five climatic zones (tropical, sub-tropical, temperate, sub-temperate, sub-arctic and arctic) across 800 meters length east-west and 200 meters width north-south and across elevation range of below 100 to 8848masl, the highest pick in the world. The mountains are experiencing rapid snow melting while the Terai is facing prolonged drought. Agriculture and other activities are adversely affected by these changes.

Both observed data and local perception reveals that climate change is no longer a future reality–it is already happening. As already mentioned, any departure from the expected "*normal*" climate poses serious threats to the livelihoods of the people of the Himalaya region (Chaudhary and Aryal 2009; Gurung et al. 2010; Sharma et al. 2009). In the last decade, the possible threat of changing climate change has received an overwhelming public attention (Maplecroft, 2011). However, we are hitherto short in understanding of climate change occurring in the nation and its impacts on ecosystems, biodiversity, agriculture and livelihoods, which have been impeding policy advocacy and real action on ground. There is a dearth of literature that describes the challenges and solutions of climate change (Chaudhary and Bawa 2011). Literature describing the roles of institutions in mitigating and adapting to climate change is also scanty (Chhetri et al. 2012). As a consequence, rhetoric has yet to be translated into action.

Even at global level, while information on observed and predicted change is amply proliferated and exchanged, adaptation techniques are poorly studied and exchanged at a wider level. Local people have been coping with changes using their own knowledge, resources, and skills (Chapagain et al. 2009) and such knowledge and skills can be taped to develop efficient adaptation plans. Adaptation techniques developed by Local Initiatives for Biodiversity, Research and Development (LI-BIRD), a national NGO in Nepal, using such

local capitals and implemented with local participation have greater chance to become sustainable, low cost, and socially feasible (Thapa et al. 2012). LI-BIRD has been working with local communities to develop locally feasible adaptation measures with the participation of local knowledge, resources and skills.

The local level examples shared in this paper can be useful for other countries that share similar threats and socio-cultural and political challenges. People in other developing world can adopt the local technologies promoted by LI-BIRD in Nepal.

3. Evidence of climate change in Nepal

Nepal has been constantly experiencing changes in weather and climate throughout the country. Temperature data analyzed for the past clearly show the increasing trend of temperature over time, although the progression is not linear (Shrestha et al. 1999; Agrawala and Berg 2002; Shrestha and Devkota 2010), nor is the change uniformly distributed across the geographic regions (Shrestha and Bawa 2012). In Nepal temperature has increased at the rate of 0.03-0.06^{0}C per annum between 1977 and 1994, with the higher altitude regions experiencing more rapid increase than the lower altitude regions (Shrestha et al. 1999; Shrestha and Bawa 2012). Another study showed a rate of 0.4^{0}C per decade between 1981 and 1998 for the country (GoN 2004). In a district in Nepal (Gorkha), an average temperature for 2001-2006 was found 1.5^{0}C greater than 1978-1982 (Lamichhane and Awasthi 2009). Other researchers have also found similar trend (Shrestha and Devkota 2010; Sharma et al. 2009). An analysis of data from Darjeeling hills of India also suggests that adjoining eastern hilly regions of Nepal are experiencing increase in average temperature, mainly during winter season (Chaudhary et al. 2011). Warming trend in the Tibet (Agrawala and Berg 2002) is also an indication of temperature rise in the mountains that are contiguous to Tibet. Not only average temperature, but several extreme temperatures (both high and low) have also been altering over time. For instance, in the past decade, both extreme temperatures were recorded the same day, which was not very common in the earlier decades (Rajbahak 2006).

Without any doubt, regional and seasonal variation of precipitation is also occurring (Gurung and Bhandari 2009). Shrestha (2000) observed an increase in average rainfall and precipitation over time. According to MoE (2010), pre-monsoon rainfall is decreasing and post-monsoon is increasing in some pockets of Western Nepal. Similarly, early monsoon and delayed withdrawal of monsoon has become normal (GoN 2004). However, it is paradoxical that precipitation has been increasing in the high rainfall regions and decreasing in low rainfall or drier regions (GoN 2004). For instance, precipitation has increased by 774mm in Lumle (high rainfall region) and decreased by 36mm in Mustang (low rainfall region) over the past four decades (DoHM 2007). Nepalgunj, one of driest cities, also sustained a wettest monsoon season in the last 123 years in 2006 (Sharma 2006).

Extreme events are also increasingly replacing normal monsoon seasons (Baidya et al. 2008); short-duration heavy downpours are more frequent than ever. In Laprak Gorkha, a total rainfall was recorded 341.8mm between 4pm to 7am (15 hours) in July 3, 1999. In Nepane

Kaski, 128mm rainfall occurred between 11pm to 12:30am (1.3hours) in July 15, 2006. Similarly, in Nepalgunj, Banke, 336.9mm rainfall was recorded in 24 hours in Aug 27, 2006 (SOHAM 2006; Gurung 2006).

Similarly, increase in average temperature of Rasuwa, Dhading, Banke and Bardiya districts was also noted between 1977 and 2007. The degree of increase was higher in Rasuwa (0.03^0C), a high mountain area, followed by Dhading (0.02^0C), a middle hill area, and Bake and Bardiya (0.01^0C), the Terai area (CARE/LI-BIRD, 2009). The study also found out a gradual increase in maximum and minimum temperature in the Terai region and an abrupt change and erratic precipitation trends were observed in the high mountain areas.

Alteration of climate change is Corroborating with the observed changes is the perception of the people of the Himalaya region (Chaudhary and Bawa 2011). People have perceived change in their climate and are based on their day-to-day observations of weather change patterns and impacts resulting from it (Chaudhary and Aryal 2009). They also associate various effects occurring at local level with the change in weather and climate based on their experiences in planning agricultural activities according to weather patterns. From local perceptions, it is obvious that temperature is rising, rainfall patterns have become erratic and unpredictable, and snow is melting faster than before in the Himalayas (Sharma et al. 2009; Chaudhary and Bawa 2011; Chaudhary et al. 2011). A study done in the Siddhi village of Central Nepal also reported the farmers' perception in the increase of temperature as well as decrease in rainfall (Shrestha and Shrestha, 2010). Another perception study on the trend of climatic hazards done among 486 shifting cultivators of eastern and central Nepal found that 45% and 55% households have experienced heavy but short-duration rainfall and prolonged drought, respectively (Thapa et al. 2012). Studies done in the western Nepal also report similar trend of temperature and rainfall (Gurung et al. 2010).

People also experience hotter summer, shorter and less intense winter, intense but short downpours, less cold days, and reduction of frost and fog (Chapagain et al. 2009; Gurung et al. 2010; Chaudhary and Bawa 2011); the proportion of people observing these changes was more for high hills than the low hills (Chaudhary and Bawa 2011). Thapa (2012) suggests that there is a delay in onset of monsoon season (shift from June-August to July-September), which is in contrast to Chaudhary and Bawa (2011) findings from Darjeeling (India) and Ilam (Nepal) hills. As already mentioned, a report by the Government of Nepal suggests an early onset and late withdrawal of monsoon. The differences in trends reported in various literatures might be the function of spatial variation as sites considered by different studies differ. People also associate several local level impacts with weather and climate change. Some of impacts are discussed below.

4. Impacts of climate change

Above-mentioned changes have ensued the following impacts: drying up of water table, early flowering and budburst in some species; adaptation of natural vegetation, cultivated crops, weeds, crop pests, and mosquitoes to higher altitude regions; and early crop maturity

leading to yield loss (Chaudhary and Bawa 2011; Chaudhary et al. 2011). The impacts are severe in several regions of the country.

As many as 70% people in a part of Nepal and Indian Himalaya believe water sources are drying up, which could have direct impacts on agriculture, wilder biodiversity, ecosystem health, and daily water use in already water-scarce hills and mountains. Erratic and intense but short-duration rainfall has been increasing the threats of landslide (MoE 2010), because short duration rain doesn't recharge or saturate soil as effectively as prolonged rain does. Impacts are also seen in watershed; for instance, lake ecosystems are greatly affected by increased siltation, decreased agricultural workforce, and declined productivity due to prolonged dry spells (Thapa et al. 2012). People may experience yield loss in major staple crops. Change in floral composition is also inevitable due to change in water regime on ground. On the other hand, several life-threatening GLOF are not far from reality (Ives 1986; Bajracharya et al. 2007). Scientists have alerted that about 25 glacial lakes in Nepal are prone to outburst, which may cause massive damage on forests, agricultural lands, physical properties, and human lives as history shows. Scientists have linked this catastrophe with increased snow melting and glacial retreat resulting from increased temperature (Bajracharya et al. 2007).

Using a remote sensing tool, Shrestha and Bawa (forthcoming) have observed a shift in flowering time in the Himalayan flora, which corroborates to local perceptions. Nearly 50% people among 250 the Darjeeling (India) and Ilam (Nepal) Himalayas have experienced an early flowering in selected species, which include rhododendron, magnolia, peach, pear, and marigold. The study found out food shortage, crop failure, loss of livestock, and water scarcity as the major shocks to the shifting cultivators, which were highly influenced by the climatic hazards and their variability (Thapa et al, 2012).

Temperature rise has also benefited the high altitude regions. An increase in temperature has resulted in the shifting of climatic suitability of crops in the Mustang (a mountainous) district of Nepal. In the case of apple, there is a clear notice of unsuitability of apple cultivation in lower elevation unlike in past years but apple cultivation is expanded in the higher altitudes (Pradhan et al, 2012). People now can also grow cabbage, cauliflower, tomato, chilly, mango and other tropical species that were not possible about a decade ago due to cold, frost, snow, and intense cold.

In Nepal's high mountain region, change in rainfall and temperature resulted in early flowering and vegetation shift. Similarly, frequent flooding in the mid and far western Terai washed away productive lands, reduction in crop yield and damage to infrastructure, livestock and human settlement; whereas the prolonged drought, drying of water sources and outbreak of pests have been threatening crop production in the western and central Nepal (CARE/LI-BIRD, 2009).

5. Local solutions: Experiences from LI-BIRD

Solutions that are locally developed by using indigenous knowledge, local resources, and participatory methods are socially acceptable and viable in long run. LI-BIRD has been

promoting several such local and participatory initiatives in rural areas of Nepal. Framework of action LI-BIRD follows and some successful case studies are presented below.

5.1. Climate integration framework

Addressing the challenges of climate change needs interventions both in the forms of mitigation and adaptation. As mitigation is a long-term process and costly in many cases, adaptation is a better choice to respond to ongoing and immediate threats. To make adaptation effective, LI-BIRD employs the following four-tier approach: (a) vulnerability assessment, (b) understanding of local knowledge in responding to climate change risk, (c) blending local and scientific knowledge, if necessary, and (d) implementing or tailoring new knowledge. For implementing new knowledge, LI-BIRD develops an appropriate policies and implements them both at national and local levels; builds local and national capacities to implement policy; generates internal and external support to provide appropriate support to local communities; and strengthens networks and partnership to improve public awareness, information sharing, community participation, lobbying, and policy advocacy. The process discussed above is depicted in figure 1.

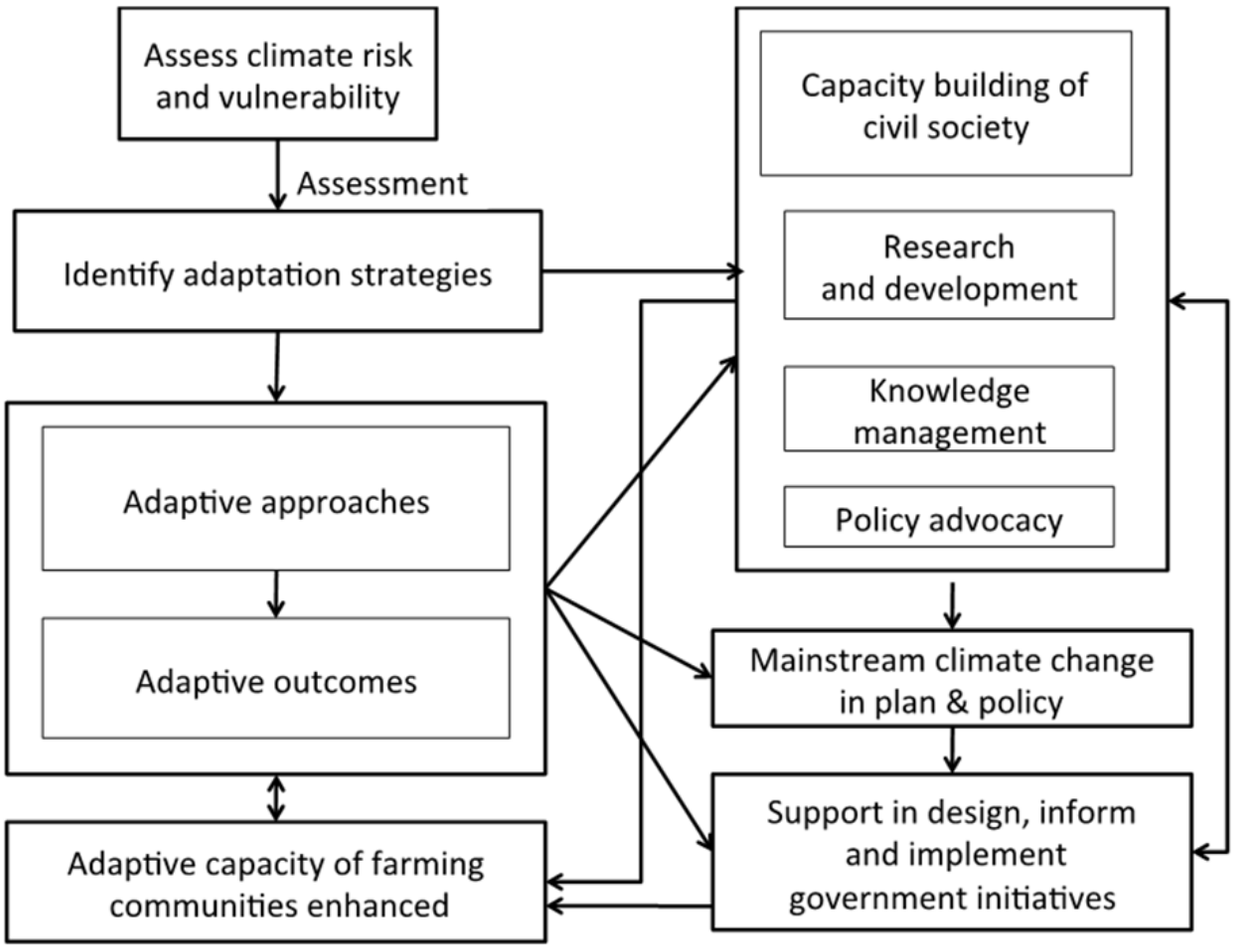

Figure 1. Climate change mainstreaming framework of LI-BIRD

LI-BIRD factors in or integrates climate change into its work. As such LI-BIRD has made its working approaches climate sensitive or has embraced climate adaptive approaches. By implementing these climate adaptive approaches in participation with local stakeholders, we have been able to generate climate adaptive outcomes, which contribute to improving the adaptive capacity of farming communities. Furthermore, LI-BIRD is using its experiences in adaptive approaches and outcomes to build institutional capacity of the Civil Society, who also need to integrate climate change. It is done through the following steps:

1. Assess climate risk and vulnerability through participatory tools and methodologies.
2. Identify potential adaptation strategies and approaches (based on community responses, LI-BIRD's own experiences of research and development, and scientific recommendations) that address the climate risks and vulnerabilities, documenting local knowledge and practices with focus on climate change adaptation.
3. Implement the adaptive approaches and strategies in the communities.
4. Build capacity of grass root organizations working in agriculture, food security, livelihood improvement, natural resources management and environment.
5. Carry out participatory research and development in collaboration with the grass root organizations and research organization to refine and develop adaptive technologies and options that are suitable to the local context.
6. Document and disseminate the field realities of climate change and climate change related knowledge and technologies generated to a wider stakeholders (communities, local government, national government, policy makers, donors, scientists and academicians, NGOs).
7. Carry out policy advocacy to mainstream climate change responses in the national development plans and policies.
8. Support national and local government and non-government organizations to design and implement climate change responsive policies, programs, and plans.

5.2. Case studies

There are several case studies that can be drawn from LI-BIRD projects to demonstrate how local initiatives and innovations can be effective to mitigate and adapt to climate change. Most noteworthy out of those case studies are presented below.

5.2.1. Community based biodiversity management (CBM)

Community based biodiversity management is a participatory approach of managing plant and animal genetic resources including the wild through conservation, utilization and value addition of the genetic resources. This approach is implemented in the community through documentation and assessment of biodiversity of the community through diversity fairs and community biodiversity register (CBR). During this process, genetic resources for conservation and utilization are identified which are then conserved and promoted through a number of tools and methodologies[1], and is helpful in assessing and identifying the

[1] http://www.cbmsouthasia.net/components-of-the-cbm-approach/

threatened crop species as well as the crops and their varieties having climate stress tolerating traits. With such tools and methodologies, CBM approach has enriched local communities with increased access to market and financial institutions, technology(ies) and practices to respond drought and flood, strengthened social institutions and cohesion thereby enhancing integrity among their livelihood resources and building resiliency of farmers in rural communities.

CBM approach has contributed to conserving and utilizing the genetic resources and associated knowledge, increasing access of genetic resources through exchange and diversifying income sources. The approach has promoted community seed banks, registration of agro-biodiversity, value addition of farm products through breeding (participatory plant breeding) and non-breeding techniques (value addition and market linkage), identification of crops/varieties that thrive best in harsh climate, establishment of group fund, and strengthening of local social institutions. Such methodologies to conserving and utilizing genetic resources have contributed to increasing adaptive capacity of poor and marginalized farmers by:

i. Increased farm income through value addition, marketing of local products (entrepreneurship development), and reduction of external inputs
ii. Increased agriculture production through integrated soil and nutrient management
iii. Provided varietal options to the farmers through conservation and utilization of diverse genetic resources
iv. Enhanced poor and marginalized people and women's access to healthy and a variety of foods, saving and credit facility (CBM fund), social institutions such as cooperatives
v. Conservation and utilization of local genetic resources and the associated traditional knowledge that have potential to contribute to climate change adaptation
vi. Empowering poor and disadvantaged women for value addition and conservation of genetic resources and their participation in farmers' institutions
vii. Developed coherence and social harmony in the communities through gender and social inclusion of disadvantaged groups in farmers' institutions and networks

Case Study I

Pratigya Cooperative in the Rupa Lake of Kaski Nepal was established in 1997 with 43 share members. In 2010, it has 78 members with 38 female members. The cooperative is instrumental in conserving local drought tolerant and underutilized crops, maintaining a diversity of crops in their field, and supporting the poor and marginal farmers to sustain their livelihoods have enhanced their capacity to deal with those climate hazards.

Value addition of local crops has enhanced their access to market and information. Their major focus is on local landrace of sticky rice, taro, finger millet, and ginger marketing. The cultivar of taro conserved and promoted as well as practices to manage marginal lands along with crop diversity in their field and seed bank are also enhancing communities capacity to respond to drought there by reducing its risk. The cooperative

members at current have promoted marketing of sticky rice, local landrace of sticky rice, after the members realized the market potential for its medicinal, cultural, and traditional value; and marketing of taro products through value addition. They have been selling products from all parts of the plant (root, pseudo stem and leaves) of taro and sticky rice through cooperatives. They sold taro products of USD 200 in 1999, whereas they earned USD 450 by selling the products in 2009. In addition, the members of the cooperative are maintaining field gene banks of different taro species and conserving the medicinal and aromatic plants.

Inclusion of indigenous *dalit* community members in the cooperative and supporting them with income generating activities are also enhancing their capacity through increased income and well-being among the community that is very important to deal with climate change uncertainties. Seed banks are established as an effective means of crop insurance at the community level. Individual member of the cooperative are assigned to maintain the seed production and conservation of those threatened crop varieties to maintain the important seeds.

5.2.2. Home garden diversification

Diversification of home gardens and its efficient management for women, disadvantaged groups including indigenous communities (*janajatis*) and *dalits* is adaptive approach at household level to address and respond to impacts like drought and floods. This adaptive approach has significantly contributed to improve nutritional status and reduce economic vulnerability of poor and disadvantaged communities in Nepal. The various components, and their efficient management, of home gardens such as kitchen waste water management, cultivation of neglected and underutilized crop species, integration of small farm animals and fish, cultivation of vegetables, integration of fruits and fodder, and market linkage have contributed to increase their adaptive capacity and make home gardens resilient to climate stress by

i. Diversified family nutrition and increased nutrition sources
ii. Increased household income and income generating options (such fruits, fish, vegetables and livestock)
iii. Increased homestead biodiversity
iv. Optimized utilization of available resources through integrated management
v. Sustainably managed social seed system l
vi. Increased institutional capacity for decision making, planning, resource utilization and benefit sharing
vii. Increased access to service provider organizations
viii. Establishment of group funds and access of resource poor and disadvantaged groups to group fund mobilization

Case Study II

Poor and disadvantaged communities of some parts of Kanchanpur, Kailali, Bardiya, Rupandehi, Gulmi, Ramechhap, Dolakha, Sindhupalchowk, Jhapa and Ilam have got benefits from home garden diversification. The farmers of Dudharakshya village of Rupandehi district have improved their nutritional status through vegetable consumption and selling in the nearby market. Livestock integration has become an important livelihood asset in the home gardens, which can be an important source of income for most of the poor and disadvantaged farmers. Some of the specific cases are (Pudasaini, 2009):

- The intervention has increased species diversity in most of the home gardens (n=690). After the intervention, households growing 26-50 species in their home gardens increased from 32% to 72%.
- Adoption of better management practices in home gardens has increased the product marketing of the households (from 15% to around 40% households). Almost all the people (n=690) who used to buy vegetables from market have increased their self-sufficiency and reduced the amount of money going out of the family for daily used vegetables.
- Number of families with 12 month vegetable sufficiency from the family home garden increased from 13% to 56%.

5.2.3. Development and promotion of stress tolerant crop varieties through PPB and PVS

Participatory variety selection (PVS), participatory plant breeding (PPB) and client oriented breeding (COB) are participatory research and development activities that help in development and promotion of stress resistant crop varieties. Participatory approaches of variety selection and breeding adopted by LI-BIRD are need based and demand driven approaches. These approaches focus on traits preferred by farmers in which farmers' preferences are determined by socioeconomic situation, land type, availability of varietal options and environmental conditions (climatic factors-niche specificity like rainfall pattern, temperature and humidity). By utilizing these adaptive research and development approaches, LI-BIRD has been developing and testing cereal crop and legume varieties that tolerate environmental extremities such as drought and flood. The outcome of these approaches is increased productivity of agro-ecosystem with changed cropping pattern, increased crop diversity and improved soil health. This approach has also contributed to enhance the adaptive capacity of farming communities to the impacts of climate change by:

i. Increasing use of stress tolerant and high yield crop varieties to improve farm income by developing high yielding and farmers' preferred crop varieties
ii. Promoting local business through local variety and employment opportunities at local level through community based seed production (CBSP) groups

iii. Providing technological option (varieties) and management option (agronomic interventions such as legume integration in farming system) to deal with climate stress, improve soil health and system productivity
iv. Increasing the access of communities to seeds (technology) and financial institutions (through CBSP groups) and market (through community based seed production groups)
v. Establishing strong social seed networking (seed and knowledge exchange) and strong social institutions (CBSP)
vi. Building capacity of communities for seed production and variety selection including flood and drought tolerant species
vii. Contributing to policy and regulation for enhancing access of poor and marginal farmers to technology and lobbying for equal benefit sharing mechanism

Case Study III

Mansara is a landrace grown in hills especially Western Mid hills of Nepal and it is highly adapted to poor soil and low-input production system. It has very low productivity, poor eating and cooking quality due to which it fetches low market price but it is adapted to marginal environments it is grown by resource poor rice farmers who do not possess varietal options. Thus, using participatory plant breeding (PPB) approach the quality and yield of the *Mansara* landrace has been improved by crossing it with a quality modern variety *Khumal 4*. Through PPB the better yield potential and good eating and cooking quality traits from modern variety has been transferred without losing adaptive traits of *Mansara* landrace. Participation of farmers to select the type of *Mansara* variety they wanted was highly valued during the breeding process. Now improved *Mansara* is superior to the original *Mansara* in terms of eating and cooking quality along with better productivity yet still adapted to the marginal growing environment, thus providing options to farmers in marginal rice growing environments.

Sugandha 1 is an aromatic rice variety with medium maturity developed by LI-BIRD using client oriented breeding (COB). The variety has a unique combination of high yield with aroma. It is highly suitable for very marginal, low input, rain-fed rice growing environments. Most of the aromatic rice varieties are prevalent in irrigated medium to lowland conditions. But *Sugadha 1* is unique as it thrives best in stress prone environments. This again demonstrates how PPB provides varietal options to farmers in marginal environments.

Judi 582, *Barkhe 1027*, and *Barkhe 1036* are other rice varieties developed using COB and are suitable for drought prone and rain-fed environments. Development of these short duration varieties has supported the farmers for growing winter cereals, legumes and vegetables making their farming system more resilient. Similarly, *Barkhe 3004* and *Barkhe 3019* are rice varieties developed using COB suitable for lowland rice growing environments and they have some tolerance to flooded conditions.

5.2.4. Payment of ecosystem services

It is a right based and ecosystem based mechanism for the sustainable management of ecosystems and natural resources, ultimately contributing in building resilient ecosystem. It is a market driven approach to natural resource management by involving the buyers and sellers in the utilization of ecosystem services. LI-BIRD in partnership with IUCN has established a reciprocal benefit sharing mechanism in the management of natural resources in the watershed between the upstream and downstream communities to demonstrate payment of ecosystem services in Rupa Lake Watershed, Kaski (Regmi et al, 2009; Pradhan et al, 2010). The outcome of this approach is rehabilitation of degraded watershed and management of associated biodiversity. Such practice offers adaptation led mitigation opportunity from a climate change perspective and enhances the adaptive capacity of watershed communities and resilience of watershed at landscape level by

i. Providing option for reducing siltation and conserving natural resources
ii. Enhancing ecological integrity of the catchment
iii. Increasing income of sellers through diversified livelihood options (fishery, value addition and marketing, ecotourism)
iv. Conserving biodiversity (white lotus, wild rice, water birds, *Sahar* fish and NTFPs)
v. Promoting traditional knowledge on rehabilitation of degraded catchments
vi. Building capacity of watershed communities for watershed management
vii. Increase in social cohesion and harmony

Case Study IV

A reciprocal benefit sharing mechanism between upstream and downstream communities is established effectively for ensuring stakeholders substantial rights to environment in Rupa Lake watershed in Nepal. The voluntary payment mechanism in the management of Rupa Watershed by downstream communities through Rupa Lake Rehabilitation and Fishery Cooperative to the upstream communities is the only documented case of payment of watershed services in Nepal.

Every year the cooperative shares some of its income in these watershed management practices to the upstream community members through their institutions. It has also mobilized mother groups to conserve the biodiversity of lake such as wild rice, birds, indigenous fishes, and white lotus. The cooperative annually pays 25% of the total income of the cooperative from fish selling to the upstream communities (19 schools, 52 students and 17 community forest user groups).

In addition, the inclusion of disadvantaged community members in the cooperatives and supporting socially marginalized community members by income generating activities like goat raring, etc. has enhanced the socioeconomic status of these community members. More importantly, it has enabled those members to send their children to the school. Social cohesion, market promotion of lake products, diversification of livelihood options, inclusion of socially marginalized community

members in the cooperatives, coordination with upstream community members to reduce siltation in the lake and conservation of biodiversity in the watershed are the outcomes of this payment of ecosystem services mechanism.

These approaches helped to identify how multiple (social, economic and cultural) co-benefits can be taken into account for establishing well functional payment for ecosystem services and promoting ecosystem based adaptive mechanism on watershed management. Hence, the role of ecosystem services in reducing the climate vulnerability through multi-sectoral and multi-level approaches has been effective in increasing access to the poor and marginalized communities in their livelihood resources.

5.2.5. Capacity building through public awareness and network

LI-BIRD has established a mechanism of raising public awareness on climate change through publication of research findings, field cases and information on climate change through mass media. Capacity building of mass media and determining the role that the media can play in order to improve information sharing, both from science to local level and from local level to policy makers, are urgent matters (Lamsal, 2011). In the country like Nepal, poor dissemination of information to the marginalized and climate vulnerable communities and their access to such information is very limited, which has also limited their capacity to adapt to the impact of climate change. In this context, the approach of utilizing mass media especially local FM radio network for climate change communication is one of the strategies to increase access of marginalized, poor and climate vulnerable communities to information and then the adaptive technologies and options.

The NGO Network on Climate Change (NGONCC) network established and facilitated by LI-BIRD is another adaptive mechanism to build the capacity of civil society organizations of Nepal. The ultimate goal of this network is to enhance the adaptive capacity of those poor and climate vulnerable communities through implementing adaptation strategies and policy advocacy at local, district and national level. Through this network, more than 120 NGOs get information on climate change issues and are regularly getting updated on the various adaptation and mitigation issues related to climate change.

Case Study V

Information sharing and capacity building is an important part of enhancing adaptive capacity in response to climate change. The members of NGO Network on Climate Change in Nepal have enhanced their capacity through a regular sharing of information related to climate change and through involving in various capacity building programmes related to climate change. The network in Nepal was initiated in 2007 by LI-BIRD. Initially, there were 12 NGOs from Kathmandu, Pokhara, Dhading and

Chitwan. Realizing the importance of human capital for dealing with climate change issues, the network has now expanded to all development regions of Nepal. There are 120 NGOs from all development regions of Nepal covering 34 districts in the NGONCC.

Some of the NGOs in the network have mainstreamed climate change issues in their programs and projects to enhance community awareness and support adaptation to climate change. LI-BIRD has been promoting awareness raising, capacity building, action researches, and community based adaptation interventions in Nepal. Youth Acting for Change (YAC), Dhangadi, Resource Identification and Management Society (RIMS), Namsaling Community Development Center (NCDC), Ilam, Dalit Welfare Organization (DWO), Banke, Environment Camps for Conservation Awareness (ECCA) and LI-BIRD host climate change information and resource center at ground level for effective information transformation and dissemination.

More importantly, the network has contributed to the preparation of National Adaptation Program of Actions (NAPA) and piloting of Local Adaptation Plans of Action (LAPA) document by providing ground realities on climate change through transect appraisal exercises and technical inputs.

6. Conclusions

Climate change research is nascent in the developing countries that bear the major portion of consequences resulting from climate vagaries. Hence, more research effort is needed to aptly understand real problems, and driving forces of such problems, and devise efficient adaptation and mitigation measures. This should be achieved by employing participatory approach as developing countries lack infrastructure to record quantitative data to measure change and make a precise prediction. While bottom up approach to identifying locally feasible adaptation tools will be a first step to generate knowledge, investment should be made to introduce advanced technologies in order to generate quantitative information so that we can easily discern change, make prediction for future, and accordingly devise national strategies with more confidence. Longitudinal research is necessary if a country can afford.

Many local adaptation techniques might be used as such while several others can be combined with scientific knowledge generated using modern tools and techniques, to make is more robust, reliable, replicable, relevant, remedial, resilient and resource conserving in nature. Several of such knowledge thus can be adopted at cross-country levels but with possible modifications to tailor to local needs and capacities.

It is also important to raise public awareness at all levels as national and local level planners, policy makers, implementers and victims of climate change have little knowledge about change process, driving factors and remedies. Even capacities of scientists and climate advocates need to be strengthened through latest scientific inventions as they lack access to

information due to costly journal fees and unreliable access of internet. Exchange of knowledge is also not efficiently done among stakeholders within country. It is important to share national, regional, and global policies, treaties, legislations and strategies with all national and local partners through their proper networks and help them tailor priorities and allocate resources accordingly. This will help them draw more resources from international and global community. More specifically, the global financial commitment on adaption in the least developed countries should be increased and committed funds (e.g. Least Development Country fund, special climate change fund, adaptation fund, climate investment fund, and green climate fund) transferred timely and appropriately through proper channels. Furthermore, the climate vulnerable countries must prioritize implementation of their adaptation programs and plans (e.g. NAPAs) to build community resilience to climate change, making sure the funds disbursed are properly distributed among target beneficiaries.

To achieve aforementioned goals, we not only require research and development fund—both public and private—but also existence of several organizations like LI-BIRD to generate, translate, and disseminate knowledge, build community capacity in adaptation, and strengthen NGO networks to expand collaboration, scale out good practices, and foster policy advocacy. There is a lot to learn from LI-RBID approach and practices, which are viable, robust, need-based, and thus responsive to real challenges. It is also important to properly integrate LI-BIRD framework with NAPA and LAPA, where the countries have privilege of mainstreaming these strategies into climate change and development plans of the country.

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