



**Climate Change and Agrobiodiversity in Nepal:
Opportunities to include agrobiodiversity maintenance
to support Nepal's National Adaptation Programme
of Action (NAPA)**



A report prepared by LI-BIRD for the
Platform for Agrobiodiversity Research
in collaboration with FAO and Bioversity International

Nepal has initiated preparation of its National Adaptation Programme of Action to identify urgent and immediate adaptation needs. The agriculture and food security issues of Nepal are deemed vulnerable to the impact of climate change. This report "*Climate Change and Agrobiodiversity in Nepal: Opportunities to include agrobiodiversity maintenance to support Nepal's National Adaptation Programme of Action (NAPA)*" is an attempt to ensure a role for agrobiodiversity in Nepal's NAPA. The analysis reviewed the context of climate change and agrobiodiversity in Nepal. It identified knowledge gaps, existing community based adaptation strategies, stakeholders' perspectives, recommending short and long term adaptation options to enhance and strengthen adaptive capacity of the poor, marginalized, and vulnerable communities of Nepal from the potential impact of climate change.

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Cover Photo: Fodder trees along rise terraces / LIBIRD Photo Bank

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Summary

Climate change is becoming one of the major environmental issues in Nepal. There is evidence that climate change is already affecting the biodiversity and weakening the livelihood assets of poor and marginalised communities. Despite this climate change has been largely left out of the Nepal Environment Policy and Action Plan. The existing government policy on the agriculture sector also takes no systematic account of the anticipated impact of climate change. The preparation of the National Adaptation Programme of Action (NAPA) is the first official initiative to mainstream adaptation into national policies and actions so as to address the adverse impacts of climate change and reduce vulnerability to changing climate and extreme events. The Ministry of Environment signed the contract in November 2008 with UNDP to officially start the NAPA formulation process in Nepal. The Ministry is planning to complete the NAPA by April 2010 with some good progress in terms of initial understanding on vulnerability context and identify preliminary sectoral issues through the mobilization of thematic working groups.

Adaptation to climate change should be considered from a contingency planning process perspective. There is a need for integration of agrobiodiversity component within the NAPA. Adaptation in the agricultural sector can be seen in terms of both short-term and long-term actions. There is a need for provision of crop and livestock insurance, social safety nets, new irrigation schemes and local management strategies, as well as collaborative research, capacity building at different levels, inter departmental coordination and focused policies. Particular attention should be paid to building on existing local knowledge, practices and innovation, including good practices on agrobiodiversity management and related sectors. Focus should be given to participatory research and development so as to: identify and develop drought, flood, pest and/or disease tolerant varieties; strengthen on-farm *in-situ* conservation and utilisation of plant genetic resources, including improve home garden diversification; strengthen farmer seed systems; enhance access to a larger portfolio of germplasm through promotion of community seed banks; promote and strengthen capacity for grassroots and participatory plant breeding to broaden the genetic base for secured food production; and develop improved measures for conservation-based ecological farming, including sustainable soil and nutrient management practices. The participation of civil society and of rural communities in national and international negotiations and decision-making is crucial.

Introduction

Climate change is increasingly accepted as a major issue facing the Nepalese people. The Initial National Communication (INC, 2004) of Nepal to the United Nations Framework Convention on Climate Change (UNFCCC) and a range of recent studies show that Nepal is highly vulnerable to the potential negative impacts of climate change. The scenarios of climate change in Nepal have indicated that significant warming particularly at higher elevations will lead to reduction in snow and ice coverage; will create an increase in frequency of climate induced disasters including flooding and droughts; and cause an uneven precipitation distribution over the regional scale. In the past decade in Nepal the damage is increasingly evident and has initiated arable land lost to flood and erosion, erratic changes in monsoon, water shortages and drought events; growing threats from Glacial Lake Outburst Floods (GLOFs), disappearing forests in some areas; invasion of exotic species, outbreak of diseases, sharp and sustained decline in food security and threats to biodiversity. These climate induced risks and hazards can have wide ranging, often unanticipated, effects on the environment and on socio-economic and development related sectors, including agriculture and food security, biodiversity, water resources, energy, human health, urban settlement, terrestrial and aquatic ecosystems (NCVST, 2009; WFP, 2009). Poor and vulnerable communities of Nepal, therefore, face possible dramatic impacts on their livelihood and well-being.

About 80% of the Nepalese population depends on agriculture for their livelihood and follow traditional cultivation practices. The projected changes in climatic conditions of Nepal will adversely affect agriculture production. Climate change is expected to lead to increasing dryness in drought-prone areas and to wetter conditions in wet areas. The plant varieties currently available in different regions in Nepal may not be adapted to new production conditions. There have already been alarming signs of sharp and sustained decline in food security in Nepal; for instance, winter food crop harvests for 2009 in all regions have declined sharply. The extreme weather phenomenon, including droughts and floods, is expected to induce food vulnerability to the already food insecure 3.4 million people in Nepal and this increases the cost of coping dramatically (WFP, 2009).

As part of the response to climate change, Nepal recently initiated the process to prepare a National Adaptation Programme of Action (NAPA) - a multidisciplinary process for least developed countries to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change. This will enable Nepal to access and utilise various adaptation funds allocated for the least developed countries. Amongst the six thematic working groups formed¹, agriculture and food security is the major areas of interest for the NAPA project. Some preliminary work has already been carried out to have stocktaking and initial vulnerability assessment of the agriculture sector.

In this context, it is important to explore the ways in which the role of agrobiodiversity is recognised as part of the adaptive strategies included within Nepal's NAPA and to determine to what extent provisions conducive to the deployment of various coping strategies including agrobiodiversity. The objective of this report is to investigate the extent to which the role of agrobiodiversity and its importance is or can be recognised in the on-going NAPA development process, to identify factors that currently

¹ 1. Agriculture and Food Security; 2. Climate-induced Disaster; 3. Forests and Biodiversity; 4. Water Resources and Energy; 5. Public Health and 6. Urban Settlements

promoted or hindered the maintenance and use of agrobiodiversity in response to climate change and to recommend actions that would enhance its contribution.

National policy responses to climate change

Nepal ratified the United Nations Framework Convention on Climate Change (UNFCCC) in May 1994 and signed the Kyoto Protocol in September 1995. The Government of Nepal identified the Ministry of Environment (MoE²) as the Designated National Authority (DNA) as part of its commitment to the effective implementation of climate change policies. The Government of Nepal prepared a National Greenhouse Gas Inventory Report and an Initial National Communication Report (2004). A second National Communication Report is currently being prepared and MoE is developing a national climate change policy. In 2008, the Government and the United Nations Development Programme (UNDP) began work on the preparation and implementation of the NAPA. There are other national initiatives like the Pilot Programme on Climate Resilience (PPCR) and Reducing Emissions from Deforestation in Developing Countries (REDD).

Policies for vulnerability and adaptation

The policies and measures needed to cope with climate change will depend on the ability to identify the likely extent and nature of its impact and the vulnerability of economic and social systems, both in space and time. While research and development activities related to the Greenhouse Gas Inventory in Nepal have progressed satisfactorily, those that address vulnerability and adaptation have not. Various constraints have been identified, the most important of which is the lack of national level data and technical capability to apply the results of Global Climate Models (GCMs) to local areas. Impact and vulnerability studies are also needed to identify and analyse potential adaptation measures vital for sustainable development in Nepal, particularly in the agriculture and water resources sectors. The lack of comprehensive research in these areas seriously limits the ability to make appropriate national policy recommendations.

Attention to climate change in Nepal's planning documents

While the current Tenth Five Years Plan (hereafter referred to as the Tenth Plan) of the government acknowledges the important influence weather can have on the overall economic performance, there is only one paragraph in the entire document wherein the development impacts of weather and climate are mentioned. Many of the proposed development activities may well reduce vulnerability to climate risks, but lacks explicit assessment. An analysis of climate change related risks and the ways to reduce them is not included. The only activities dealing directly with climate risks in the Activities Matrix attached to the Tenth Plan are two emergency management items in the urban development section, namely construction of emergency shelters, and provision of housing for disaster-affected families.

The overall national Medium-Term Expenditure Framework (MTEF) developed to ensure appropriate allocation of resources to different sectors does not discuss climate risks either. The lack of specific climate risk management items need not be a reason for concern as, ideally, climate risk management would be mainstreamed in many of the sectoral activities in the MTEF and the Activities Matrix of the Tenth Plan

² The Ministry of Environment, Science and Technology have been recently reformed into Ministry of Environment.

(such as hydropower development and agriculture projects). However, effective mainstreaming still requires explicit attention at the policy level, which is not reflected in the Tenth Plan.

The sectoral MTEF paper for agriculture pays some attention to climate-related factors. It mentions the criticality of the monsoon season for the sector and lists the country's agro-climatic potential as an opportunity. A number of investments likely to reduce vulnerability to climate related risks are identified and a general proposal is made to use research funds to support needs based adaptive research. Relevant solutions suggested for sites where adequate and perennial water sources are lacking, include water-harvesting schemes and solar pumps. However, there has been concern that the paper does not address the generic problems of an outreach approach characterised by a top-down approach and a lack of orientation on small farmers' problems, namely "rain-fed and poor soils". Moreover, while climate risks gain attention, specific actions to address the risks of change are not addressed.

Gaps in government policies and development plans

At the national level, evidence suggests that the impact of climate change and the actions needed to confront climate change have yet to be embedded into policy and planning processes. The Tenth Plan has poverty reduction as a central focal area, which in turn has been developed as the country's Poverty Reduction Strategy Plan. As noted above, both the overall and sectoral MTEF papers pay little attention to climate change concerns even where there is attention to problems associated with the current situation. Climate change has also been given little attention in the Nepal Environment Policy and Action Plan recent reports to the UN Convention on Biodiversity, UN Convention on Combating Desertification or in its report to the World Summit on Sustainable Development (WSSD).

In the context of the maintenance and use of agrobiodiversity there is a particular need to strengthen existing agriculture policy in order to take account of climate change.

The National Adaptation Programme of Action (NAPA) in Nepal

The National Adaptation Programmes of Action (NAPA) intend to take into account the existing coping strategies at the community level and to build upon these to identify priority activities, rather than focusing on scenario-based modeling to assess future vulnerability and long-term policy at the national level. It is therefore, important for the least developed countries, such as Nepal, to identify community-based coping strategies of climate induced vulnerability and the scaling up of adaptation and integration of climate change into national development plans. The goal of a NAPA is to enable countries to respond strategically to the challenges and opportunities posed by climate change. A key strategy of the NAPA is to ensure comprehensive stakeholder input in all stages of the implementation process, involving national and local level government institutions, non-governmental organization, civil societies groups, academia, international organization and donor agencies.

In Nepal the Ministry of Environment is the lead agency for the preparation of the NAPA as part of a team which also includes representatives of government agencies and civil societies. The NAPA team is currently working with a broader multidisciplinary group through its six thematic working groups to conduct the tasks in the preparation of the NAPA.

The steps for the preparation of NAPA include synthesis of available information, participatory assessment of vulnerability to current climate variability and extreme events and of areas where risks would increase due to climate change, identification of key adaptation measures as well as criteria for prioritising activities and selection of a prioritised short list of activities by each development sectors (UNFCCC, 2002).

The NAPA will develop a strategic framework of action for climate change in Nepal, based on the identified immediate priorities for climate resilient and low carbon development, based on which stakeholders can align their responses. Based on the analysis of climate change impacts on various sectors, the key climate change adaptation priorities will be identified, including capacity development needs at the individual and institutional levels. The government of Nepal signed the NAPA contract with UNDP in November 2008 and has a strategic plan to report final draft findings of the NAPA document by April 2010 to the UNFCCC secretariat. There were a number of problems contributing to the delay of the NAPA process in Nepal. These included difficulties in accessing and managing the fund, the political turmoil in Nepal and the lack of government priority. However, now that the NAPA development is in process, there is need to assist in its completion and submission.

Stakeholder involvement

The NAPA document for Nepal (MoE and UNDP, 2008) outlines the management arrangements and structures necessary to achieve the NAPA preparation. These include establishing an Advisory Board, Thematic Working Group and Working Team. The Advisory Board, whose role is to oversee coordination among partners and institutions working on climate change is planned to include representatives from the various relevant ministries and representatives from donors, academia, civil society and the private sector. At present, the tentative list of members appears to exclude the vulnerable communities, the community based organisations and non-government organisations working at the grass-roots.

A stakeholder analysis undertaken through consultation with a wide range of possible stakeholders (Fig 1) identified communities, especially vulnerable groups such as indigenous people and women and their representatives as key stakeholders in terms of the expected effects of climate change who are in danger of being marginalised in the process of NAPA development.

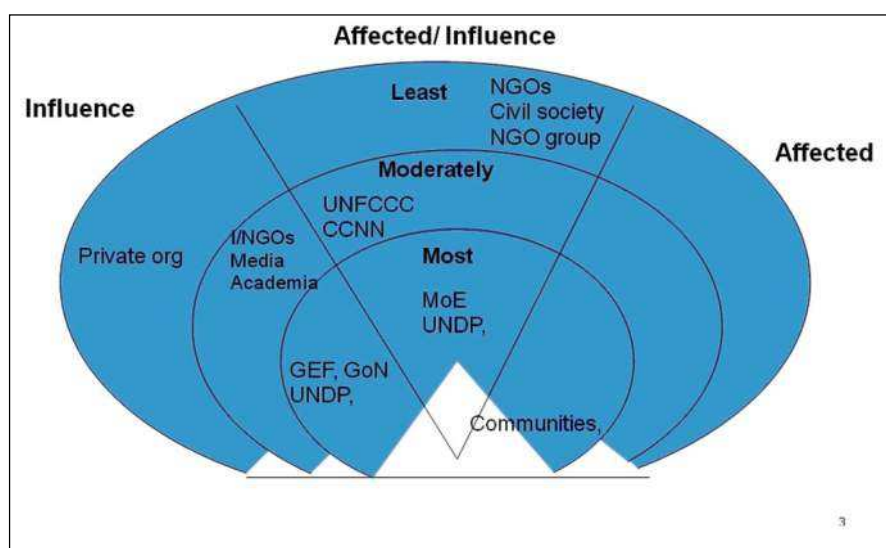


Figure 1. Stakeholder analysis of NAPA

The Nepalese NAPA and Agrobiodiversity

Nepalese smallholder farmers are largely poor with limited access to external resources and are likely to be particularly vulnerable to climate change. The farming in Nepal is characterised by mixed farming and livestock production systems, which have rich diversity. Forest, home gardens, agroforestry (with richness of fodder trees) and productive fields all embed diversity rich maintenance and use practices that increase adaptability and reduce vulnerability (Figure 2). Communities maintain rich species and intraspecific crop diversity both to help manage climatic adversity and meet their other needs (Jarvis et al., 2008).

Many of the farming areas of Nepal are also environmentally marginal and are likely to be at increased risk of land degradation and biodiversity loss as a result of climate trends. The continued availability and use of agrobiodiversity in Nepalese farming, particularly by smallholder farmers, is likely to play an important role in adaptation to climate change. The analysis



Figure 2: Fodder trees along with terrace rises. Photo: LI-BIRD Photo Bank

below shows the ways in which consideration of agrobiodiversity maintenance and use should become fully integrated into the NAPA process.

Vulnerability of agriculture to climate change and potential role of agrobiodiversity

Agriculture in Nepal and the effects of climate change

The agriculture sector contributes nearly 33% of Nepal's Gross Domestic Product (GDP) and supports the livelihoods of more than 86% of the population (CBS, 2007). Most of the Nepalese population depends on agriculture for its livelihood, which is based on a rich diversity of useful species. Of the more than 6,000 vascular plant species found in Nepal, about 550 species and subspecies have food value and some 200 are cultivated (MoFSC, 2002). The diversity of livestock (both improved and indigenous breeds) also plays a major role in contributing to the well-being of rural communities. The diversity can be illustrated even for staple cereal crops where in different production zones and conditions rice, wheat, barley, maize, finger millet and buckwheat are all important grain staples.

The GCM projections indicate a potential increase in temperature over Nepal of 0.5-2.0°C with a multimodal mean of 1.4 °C by the 2030s, rising to 3.0-6.3 °C with a multimodal mean of 4.7 °C, by the 2090s (NCVST, 2009). For precipitation GCMs project a wide range of changes, especially in monsoon: -14 to 40 % by the 2030s

increasing -52 to +135 % by the 2090s (NCVST, 2009). This projection suggests that Nepal's agriculture will face many challenges over the coming decades due to climate related variability. Existing problems such as soil degradation and increasingly limited water resources are likely to be exacerbated by climate change, increasing the difficulty of achieving food security for the growing population. The recently observed extreme severe weather events between 2006-09 including droughts and floods have significantly affected food production in Nepal (WFP, 2009). In addition, it has been suggested that warming of more than 2.5°C could reduce global food supplies and contribute to higher food prices (UNEP & UNFCCC, 2002).

It is likely that climate change and increasing variability will have both negative and positive impacts on the subsistence farming systems in different production systems. However, the combined effects of increasing CO₂ levels, rising temperatures and changing moisture availability are likely to be complex and are still largely uncertain.

An analysis done by the Nepal Agriculture Research Council (Gautam, 2008) using simulation models for major crops such as rice, wheat and maize suggested that rice yields might increase under elevated CO₂ and 4°C increase in the Terai (lowland) (3.4%), hills (17.9%) and mountains (36.1%). Similarly, wheat production might increase by 41.5% in the Terai, 24.4% in the hills and 21.2% in the mountains under elevated CO₂, but there would be a significant decrease in production with a 4°C rise. Maize yields were expected to increase in the hills and mountains, but decreased in the Terai with 4°C rise (Sherchand et al., 2007 cited in Malla, 2008; Gautam, 2008).

Many farmers report positive effects from climate change. Farmers of the Mustang and Manang districts have noticed improved apple sizes in recent years. Other farmers are able to grow cauliflower, cabbage, chili, tomato and cucumber, which used to require greenhouses in order to survive. Local fruits have better sizes and tastes (Dahal, 2005). Similarly, a farmer in the Murza VDC (village development committee) of the Myagdi district in Western Nepal reported that the rice cultivation is becoming possible in higher elevation currently from 1,800 m to 2,400 m (Dahal, 2006).

A number of negative effects of major concern to farmers have also been described. Over the past three years, the delay in monsoon season experienced in Nepal has changed the cropping pattern and crop maturity period. It has delayed the planting and harvesting season by a month, which has in turn affected rotation practices. The delay in monsoon season has also made thousands of hectares of farm land fallow and reduced production due to lack of water (Regmi and Adhikary, 2007). A drought in the Eastern region of Nepal decreased the rice production by 30% in 2006 and heavy flooding in the mid-Western and far-Western regions in 2006 and 2008 destroyed crops in many places (Paudel, et al, 2008). There is also evidence that the vector borne diseases in livestock are increasing, forcing the livestock population to move to higher altitudes (Practical Action, 2008).

Some farming communities (from Bardiya and Kanchanpur districts) have related the loss of local landraces to climate change. They state that local landraces require a longer rainy season and that in the past 15 years the duration of rainfall has decreased. These local landraces have been replaced by short duration modern varieties. Farmers have also described effects on beekeeping and an increase in insect and pest numbers.

The increased unpredictability and intensity of weather events and hazards have been described by farmers as causing significant disruption to rain-fed agriculture, contributing to the loss of local landraces of crops change in timing of fruit tree and coffee flowering, a decline in some local grass species and reduced size of some fodder trees. Livestock numbers have declined in some areas and this has negatively affected the diet of the population (Regmi, et al., 2009).

The importance of agrobiodiversity and community based adaptation strategies

Climate variability and risks have always been a part of agriculture, due to which farmers have developed many ways of managing risks. Searching and exchanging drought-resistant seeds and other abiotic stress-tolerant crop varieties and adopting and practicing specific soil and water management practices for marginal areas have long been core activities of the farming communities. Climate change introduces a new dimension to the problem. The unprecedented rate and magnitude of climate change presents great challenges to farmers, researchers and policymakers alike and all need to collaborate at local level to address this problem. There is abundant scientific evidence that agrobiodiversity has an important role to play in ensuring the adaptation needed to maintain production.

In South Asian countries, particularly India, Nepal and Bangladesh, farmers are already adapting to changing conditions by using traditional seed exchange practices that are part of established seed systems. Farmers can also use their knowledge of abiotic stress tolerance and adaptability in their materials and work with plant breeders to develop varieties that are adapted to changing local conditions and possess improved yields and quality (Jarvis et al, 2007). Many adaptation practices involving crops and livestock have been reported (e.g. Reid and Swiderska, 2008). Traditional farming system management practices and farmers' innovations are clearly a key element in local adaptation to climate change. While scientists and policymakers work to find solutions, local farmers have already amassed considerable experience of how to cope, based on their observation and experimentation in the field (Reid and Swiderska, 2008).

A comparative study (Bhandari, 2009) of hill and Terai agroecosystems found that more households (40%) in the Terai rather than in the hills (11.6%) reported production decreases (of 5-25%) due to abnormal rainfall. It has been suggested that the continuing richness of traditional varieties in the hills places an important part in explaining this difference. A higher risk of food insecurity during abnormal rainfall years in the Terai has also been noted due, perhaps, to vulnerability of modern varieties. Through farming practices farmers are able to keep traditional varieties adapted to changing growing conditions and social preferences. The varieties are open, dynamic genetic systems constituting metapopulations whose genetic constitution reflects both natural and human seed selection.

The importance of maintaining a portfolio of crop varieties was demonstrated recently in the Western Terai Landscape Complex Project. Farmers in the Kanchanpur district had lost their local landraces of rice because they prioritised high yielding early maturing varieties. The project made available traditional local varieties, such as *Tilki* and *Shyamjeera*, and these were found to survive flooding caused by a major flooding in October 2008, which caused widespread destruction and some loss of life. A very short duration local rice variety, *Sauthariya*, has also been shown to be useful and is planted when other varieties fail as a result of drought.

Stakeholder perspectives

A consultation workshop organised by LI-BIRD and Bioversity International in Nepal, involving different research, community, farmer and international organisations, identified a number of dimensions of climate change and the maintenance and use of agrobiodiversity. It considered particularly factors of importance for the loss of diversity and for adaptation.

Factors contributing to loss of diversity include:

- Rising annual temperatures affect crop growth cycles and reduce crop yield and productivity. This alters crop and variety suitability;
- Intensive rainfall events, increases in frequency and intensity floods, and changes in monsoon patterns triggering physical loss of fertile soil and sedimentation problems;
- Extreme events change land use patterns and contribute to desertification and acidification and, in turn, alter patterns of crop and variety use;
- The use of modern and hybrid varieties creates condition where local traditional varieties are at risk of extinction;
- Narrowing down of genetic resource base and higher dependency on external seeds causing increased vulnerability among the resource poor farmers;
- Outbreaks and extension of minor diseases, pests and unwanted weeds, cause major problems in crop and livestock sectors.

In practice, since agricultural crops and livestock species and varieties are selected for specific environments (soil, temperature, humidity, sunshine period and water/irrigation, rainfall regimes) then the diversity is likely to be significantly affected by climate change. Locally adapted materials (traditional crop and livestock varieties) are likely to be particularly affected due to poor policy and institutional support for farmer seed maintenance and exchange practices.

Some major issues in adaptation to climate change include:

- Need for new crop varieties, livestock breeds and fish types that can resist or tolerate higher temperatures and changed moisture availabilities;
- Obstacles to use diversity (especially local landraces, wild relatives and neglected or underutilised species) in current research and development programmes;
- Change in cropping patterns and land use practices;
- Loss of labour through migration in traditional small-scale farming systems;
- Inappropriate intellectual property rights regimes and issues of access to and benefit sharing mechanism in use of crop and livestock genetic resources;
- Biotechnology and the growing interest in using high yielding varieties;
- Increasing interest in biofuel production;
- Loss of local knowledge of traditional management and adaptation strategies.

The workshop noted various opportunities to use agrobiodiversity in adapting to climate change in Nepal. These included:

- A rich diversity of genetic materials adapted to a wide range of production systems offers good opportunities to identify and breed for changed production conditions and stress tolerance. Local varieties are likely to provide significant adaptability and adaptation to changing climates;
- A rich in traditional knowledge maintained by a wide diversity of local and ethnic groups in diversified agro-ecological condition;
- Extensive experience of supporting on-farm management of plant genetic resources promoted jointly by LI-BIRD, Bioversity International and Nepal Agriculture Research Council and mainstreamed by Ministry of Agriculture and Cooperatives;

- Richness in the diversity of underutilised and neglected crops and the wide scope for their promotion;
- A number of good practices of community-based conservation and use of genetic resources such as: value addition and marketing; grassroots breeding for landrace enhancement and seed production; participatory plant breeding for trait enhancements of landraces and local varieties; community seed bank; and so on readily available for dissemination to wider farming communities;
- Commitment of donors, government sectors and civil society organisations to work together in an integrated manner to share information and strategy development to maintain and use agrobiodiversity;
- Development and promotion of organic farming;
- Recognition of importance of integrated production systems such as home gardens, which involve the maintenance and use of high levels of diversity and ensure improved provision of ecosystem services.

Approaches of different types at a range of spatial scales and levels are needed accompanied by the necessary policy and institutional support.

The important challenges identified include:

- Developing effective monitoring and adaptation programmes based on proper prioritisation of urgent actions;
- Strengthening capacity of people and institutions to cope with climate change with appropriate financial support and inter-sectoral linkages;
- Building an adaptive agronomic infrastructure to respond to climate change events that ensures optimum use of agrobiodiversity;
- Increasing importance of climate change work in research and development programmes;
- Increase investment in building local and national capacity in research and development for utilising agricultural biodiversity as a sustainable strategy for climate change adaptation;
- Ensuring climate change perspectives are reflected in the political transition and peace building efforts/processes.

Strengthening the inclusion of agrobiodiversity in Nepal's NAPA

The NAPA process is just beginning in Nepal, which provides an opportunity to find ways of ensuring the role of agrobiodiversity in adaptation is included. Information on the maintenance and use of agrobiodiversity, an appropriate policy and institutional framework, relevant research and adaptation actions that can be adopted by farmers constitute important aspects for optimising the use of agrobiodiversity in adaptation to climate change.

Strengthening information and communication on conservation and use of agrobiodiversity

Substantial information on agrobiodiversity maintenance and use already exists in Nepal, but is often scattered and not readily available. An assessment of the needs of different groups, especially policy makers and rural communities, is required as is a programme to ensure the information is made available to support these needs. This would likely involve strengthening local, regional and national information systems with additional data on agrobiodiversity and on climate change parameters, while improving documentation of crop, livestock, fish and agroforestry genetic resources. Specific attention should be paid to recording indigenous knowledge and technologies to counter climate change and strengthening mechanisms of sharing

information on successful community-based adaptation mechanisms using agrobiodiversity.

Developing appropriate institutional mechanisms and policy support

A number of national groups might usefully be established to provide a wider framework of concern with and action on climate change related matters. These might include a National Forum (structure) on Climate Change involving all relevant stakeholders including farming communities, a National Panel on Climate Change (NPCC) under the International Panel on Climate Change (IPCC) to facilitate the scientific understanding and research in areas related to climate change, and a Think Tank or subcommittee within the current National Agrobiodiversity Committee, under the Ministry of Agriculture and Cooperatives (MoAC) to deal specifically with climate change issues in order to offer technical assistance to the NAPA formulation process. The MoAC might also wish to open a climate change cell within the Ministry. Other actions should be identified which would strengthen civil society movement, strong networking and coordination amongst the NGOs, INGOs and GOs and raise awareness of policymakers and rural communities about the way in which climate change is affecting agricultural and rural development.

At the local level additional ways are needed for strengthening institutional mechanisms through which farmers and vulnerable communities can access resources and increase their involvement in decision making. One possible modality is to form local, regional and national committees on adaptation to ensure farmers participation. Others means include strengthening and promoting farmer-to-farmer networks by prioritising them in policy and in climate change adaptation mechanism in the NAPA and supporting ways of documenting and sharing community level local knowledge and good practices of agrobiodiversity management.

A number of policy initiatives would help ensure inclusion of agrobiodiversity perspectives in the NAPA. Some of these are very general, including a review of current agriculture and agrobiodiversity policies in the light of climate change and improved targeting of funding, which emphasises public/private partnerships. There is also a need for a shift in research and development approaches to place greater emphasis on the use of agrobiodiversity (e.g. crop wild relatives in plant breeding) and improved participation in policy development, particularly of indigenous peoples and women.

Farmers' access on the financial resources and technology related to agrobiodiversity management is also important and appropriate intellectual property regimes need to be developed. There is also a need to develop incentives to farmers: agro-ecosystems and agro-biodiversity provide a range of goods and services including food, fodder, climate change mitigation, biodiversity conservation and water quality options. These public goods benefit the maintenance of agrobiodiversity, but are not fully reflected in farmer incomes. With growing pressure on land, demand for crops for activities, such as biofuel production, will increase the demand for agrobiodiversity. It is crucial that farmers are encouraged to continue farming. This requires some form of incentive system for farmers. The design of payment for ecosystem services mechanisms to encourage them to continue farming.

Undertaking relevant research

Research to identify the optimum adaptation strategies and practices should be a key element of the NAPA. This is likely to need to be ongoing and responsive as the climate changes. It should include public-private partnerships, undertaking adaptive

research on wide scales that benefit small holders and vulnerable farming communities. In addition the Nepal Agriculture Research Council and Nepal Academy of Science and Technology should invest in and prioritise basic and long term research on conservation and use of agrobiodiversity in the context of climate change impacts. Some institutions, such as the national genebank and community level seed banks, will play key roles linked to participatory crop and livestock improvement programmes and improved seed exchange practices. A wide and integrated programme of research on resilience, adaptation and the maintenance of ecosystem services should be encouraged and linked to work at farm level on adaptation practices.

Supporting farmer adaptation strategies

Some practices have already been identified as likely to support adaptation to climate change. These can be included in the NAPA and supported at farm level. Examples include *in situ* conservation of crop and livestock genetic resources, maintenance of local seed systems, improved farmer access to genebanks, promotion of a wider portfolio of varieties and crops (particularly a number of neglected and underutilised crops), and identification of adaptive traits and inclusion in crop and livestock improvement programmes, including grassroots and participatory breeding.

Adaptation activities should take account of local and indigenous knowledge and participation and of the importance of some resilient and diversity rich production systems such as home gardens. The Community-based Biodiversity Management (CBM) approach supported by LI-BIRD and other organisations is a holistic way to integrate crops, forestry, fish and livestock to mitigate negative effects of climate change at the local level.

Conclusions

An essential part of any country's adaptation and mitigation activities in respect of climate change will involve agriculture and food production. The ability of agriculture to adapt to and cope with climate change depends on many factors, including population growth, poverty and hunger, arable land and water resources, farming technology and access to inputs and knowledge, infrastructure, agricultural extension services, marketing and storage systems, rural financial market, and economic status and wealth. The ability to maintain and deploy the full range of diversity present in and around agroecosystems will also be a major factor.

A number of policy documents have identified existing challenges in relation to the environment and to natural resource management and have also recognised the impact of weather events and natural disasters. However, climate change issues have not yet become sufficiently prominent in government development plans. While recent agricultural strategies have some focus on combating environment and adverse effects, the existing policy on agriculture takes almost no account of the anticipated impacts of climate change.

In Nepal, the development of the NAPA has started and the government plans to complete it in 18 months. Currently there is an ongoing debate and discussion amongst government and civil society, mostly in agriculture sector, about the national adaptation strategies and actions on agriculture and food security. The participation of all those involved in the agriculture sector is also central to this discussion.

There is clear evidence and an increasing recognition among a number of sectors for the importance of agrobiodiversity to build adaptability and resilience of rural communities and agroecosystems and, thus, supporting adaptation to changing conditions under climate change. The conservation of local crop and livestock landraces and traditional practices can help farmers cope with many different types of adversity. There are number of good practices in agrobiodiversity management that can enhance the adaptation capacity of farmers to adverse impact of climate change (http://www.agrobiodiversityplatform.org/climate_change). Farmers and rural communities in Nepal and around the world are already adapting to climate change and developing new practices to meet changing circumstances. This needs to be supported with new materials and relevant new practices provided in appropriate ways.

These good practices should be reflected in the national NAPA and policy making process. There is real opportunity to work with the thematic working group under NAPA to strengthen and streamline agrobiodiversity component within the analysis and planning process. Furthermore, the access of communities in the technology and funds are crucial in order to make them more resilient to climate change. Participation of civil society, indigenous people and vulnerable communities in the national policy processes and decision making and international negotiations should be ensured in future. Furthermore, inter-departmental coordination, collaborative research, training and capacity building is extremely necessary to enhance strategies and measures.

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