Adaptation Committee
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Short case study

Livelihood Adaptation and Diversification in Agriculture Sector: Case studies from FAO projects in Bangladesh, Nepal and Lesotho

Background

Communities and households depending on agriculture and allied sectors are exposed to different forms of vulnerability that include: climate-related shocks (drought, hurricanes, tidal waves, floods, heavy snow, early frost, extreme heat or cold waves), pest and disease epidemics (insect attacks, predators and diseases affecting crops, animals and people), economic shocks (drastic changes in the national or local economy and its insertion in the world economy, affecting prices, markets, employment and purchasing power), seasonal stresses (hungry season food insecurity), environmental stresses (land degradation, soil erosion, bush fires, pollution), structural vulnerability (lack of voice or power to make claims). Vulnerability to the various types of climate events is not homogeneous across geographical areas or within communities. Some communities and some households within given local context will be more vulnerable than others.

A livelihood perspective suggests that households with a larger bundle of assets will be more resilient to a climate risk than a relatively asset-less household.[1] It is not just the amount of any one asset that counts – for example, in the event of a livestock disease epidemic, a rich pastoralist household could also lose its entire herd just as a poor household. The important point is that the "capitals" are to some extent fungible. Thus, the rich pastoralist household would be more resilient to climate risks if it could draw on financial reserves to buy food and restock, or enable educated/skilled household members to migrate temporarily for employment in another area. The poor pastoralist household may have no assets other than its dead animals, and the climate risk could result in a huge and un-surmountable tragedy.

Diversification of agriculture refers to the change from a dominance of one crop or agricultural enterprise to production of a number of crops or number of enterprises to meet increasing demands for different diets and also to meet the requirements to match the changing context. There are number of advantages of economic diversification in agriculture sector, which includes management of climate risks, improve soil health and agro-ecosystem services. Crop diversification helps to benefit households and communities to secure returns from different value-added crops or multiple enterprises. This paper elaborates some successful case studies focusing on livelihood and economic diversification in agriculture. The second phase of the work will seek to integrate the livelihood adaptation and diversification into NAPs prioritization processes.

Case Study 1: Livelihood Adaptation to climate change in Bangladesh (LACC)

Bangladesh, due to its geo-physical position and socio-economic context, is highly prone to regular climate related hazards and the impacts of climate change. The Food and Agriculture Organization of the United Nations (FAO) conducted a project at the request of the Bangladesh government that was designed to improve the adaptive capacities of rural populations and their resilience to drought. It also aimed to inform service providers and policy-makers of the learning and findings, in order to improve support to future

[1] FAO (2008) The Sustainable Livelihoods (SL) Framework, Disaster Risk management systems analysis: A guide book. FAO, Rome, 78p.

adaptation processes. The project is implemented under the Comprehensive Disaster Risk Management Programme (CDMP), by the Department of Agricultural Extension (DAE), and in collaboration with the Departments of Fisheries, Livestock and Forestry and national research institutes such as Bangladesh Rice Research Institute (BRRI) and Bangladesh Agricultural Research Institute (BARI).

The planning for livelihood adaptation actions started with: the characterization of livelihood systems; profiling of vulnerable groups; assessment of past and current climate impacts; understanding of local perceptions of climate impacts, local coping capacities and existing adaptation strategies. Based on those findings the project promotes institutional and technical capacity building within key agencies and among farmers associations/groups for demand responsive services needed by farmers to better adapt. The project has developed a menu of good practice adaptation options, which guided field testing of locally selected adaptation practices. Participatory extension was key and included: demonstrations, orientation meetings, field days, farmer field schools, and community rallies. This case study presents a typology of livelihood adaptation and diversification strategies successfully implemented to promote community-based adaptation in agriculture. For details, please refer the book on community based adaptation in action – A case study from Bangladesh[2].

Improved irrigation efficiency: Irrigation efficiency and water productivity can be improved by practicing innovative cultivation methods such as the system of rice intensification (SRI), direct-sown rice culture and drought tolerant varieties. Physical adaptation measures to reduce drought impact on agriculture mainly focused on improved irrigation efficiency during winter rice (*boro*), crop diversification during summer (*kharif* II and *boro*), rainwater harvesting during the monsoon season (*kharif* II), and use of surface and groundwater for supplemental irrigation (*kharif* I and II).

As water becomes a limiting factor, improved irrigation efficiency will become an important adaptation option especially *boro* season (mid December - mid June), because irrigation practices for *boro* are water intensive. In that respect, SRI and direct sown rice will be highly beneficial. Climate change is expected to result in decreased fresh water availability (surface and groundwater) and reduced soil moisture during the dry season (*boro*), while the crop water demand is expected to increase because of increased evapotranspiration caused by climate change and the continuous introduction of high-yielding varieties and intensive agriculture in the Barind areas of Bangladesh.

Although the technical and financial feasibility of such adaptation is promising, it might require adequate training and extension (institutional support). Poor dissemination of these techniques and the weak financial capabilities of the farmers may prove to be the limiting factors in this case. Various forms of water pricing are already in practice in the irrigation schemes; however it will need to be re-visited as the water pricing is very low and charged by the hour, not by volume. Promoting optimal use of both surface and groundwater also may be a possible option although only when applied with great care. In terms of groundwater usage, some areas are already under threat of over-abstraction. Availability of groundwater is therefore a very pertinent question and it is necessary to know the rate of groundwater re-charges and at what level extraction exceeds re-charge**.**

Crop diversification and intensification: Adaptation practices need to target *transplanted aman* rice (June – November), the most important and predominant crop in the Barind Tract under rainfed situations. In non-irrigated, rainfed areas, cropping intensity is 100 percent (one crop in a year). Current activities revolve around the monsoon season and dependency on transplanted *aman* rice. However, adaptation options need to relate to increasing cropping intensity by adjusting practices and supporting efficient use of limited resources. Careful adjustment of cropping systems involving pulses and oilseeds would be highly useful for using residual moisture from the transplanted *aman* crop. The most suitable crops for exploitation of residual moisture after transplanted *aman* rice are mustard, chickpea and mung bean. These crops already are being grown in this region to a small extent. Efforts to intensify it further require careful analysis of rainfall patterns. Introduction of pulses and oil seeds in principally mono-cropped areas could increase the nutritional

[2] FAO (2008) Community based adaptation in action – A case study from Bangladesh, FAO, Rome, 55p.

security of the local people. Introduction of green manure in the system just before transplanted *aman* is also another feasible adaptation to improve the soil's water-holding capacity and nutrient content.

Emphasis on more drought-resistant crops in drought-prone areas should help reduce vulnerability to climate change. For example, wheat requires significantly less irrigation water compared to *boro* paddy. Diversification towards high value crops is feasible in the medium to long term. Growing mango in the Barind tract shows long-term promise. Overall, crop diversity is a high priority adaptation measure in both irrigated and non-irrigated areas. However, because of the traditional high dependence on rice, diversification becomes a slow process.

Alternative enterprises: The Barind tract offers many opportunities to promote alternative enterprises able to withstand the shocks due to droughts. Promotion of alternative enterprises helps increase overall household income as a drought risk management strategy. It minimizes the impact of drought through stabilization of year-round income from one source even if all other sources fail due to drought. This can include promoting such enterprises as economically viable livestock management, fisheries, sericulture and homestead gardening. Alternative enterprise will also help reduce the internal and temporary migration during the *monga* (seasonal famine) season.

Financial and market risk management: Success of adaptation practices depends on access to credit, especially for the vulnerable population including small farmers and wage labourers. Access to credit requires institutional support and is a high priority for the agriculture and allied sectors. As new practices and crops evolve, additional investment costs and institutional support will be necessary. Guidelines also are needed to incorporate climate change in long-term planning with sufficient credit facilities. Though a stable market system is evolving in response to autonomous adaptations such as mango cultivation, it will require solid institutional support for the adaptation practice to continue. Establishment of cold storage facilities, processing industries and packaging are the types of requirements that must be met if local people are to stabilize their adaptation practices.

Household level income generating livelihood activities: Household-level income-generation activities have potential to integrate women into the implementation of adaptation practices. Some of the household-level income-generation activities are: pottery, bamboo work, weaving, wood working, manual oil grinding, making hand fans and rearing silk worms. Sustainability of these household-level, income-generating livelihood activities depends on availability of raw materials. Thus, adaptation options include activities such as afforestation, and introduction of mulberry cultivation and annual crops such as mustard that take advantage of residual moisture from previous crops.

Processing/manufacturing industries: There is potential to strengthen the few processing and manufacturing industries already in operation in the Barind region of Bangladesh by providing institutional support. Those that have potential are processing of rice husks, rice brand oil, flour mills, mango pulp and oil mills. These industries also could provide adequate employment and income generating opportunities to the local population.

Case Study 2: Managing climate risks and adapting to climate change in Nepal

The impacts of climate change on agriculture and food security are increasingly evident in Nepal. Growing vulnerability to floods, droughts, landslides, heat waves and animal/plant pests and diseases are the main threats to agriculture and food security in the country. FAO provided technical support to strengthen capacities for climate risk management in the agriculture sector through its technical cooperation programme (TCP) between 2009 and 2012. The case study presents the lessons learned and recommendations for better management of climate risks and adaptation to climate change[3].

[3] FAO (2014) Managing climate risks and adapting to climate change in the agriculture sector in Nepal, FAO, Rome, 143p.

Agriculture is the principal economic sector, on which over 65 percent of the population depends, but it is poorly diversified and largely dependent on variable monsoons. Most farms are small, and there has been little adoption of modern technology because of under resourced agricultural support services and weak supply of agricultural inputs. Within the agriculture sector there are limited structures and resources for proactive climate risk management and adaptation to climate change. Strengthening of these areas required coordinated efforts at the national and local levels. Initiatives by Ministry of Agricultural Development (MOAD), especially Department of Agriculture (DOA), the Department of Livestock Services (DLS), Nepal Agriculture Research Council (NARC), and regional and district agriculture development offices are critical to the mainstreaming of risk management and climate change adaptation into agriculture.

Institutional and technical capacity development was the key priority for improving MOAD's position as a key actor in adaptation. Institutional and technical capacity needs to be enhanced at the national and district levels, particularly in DOA and the Department of Livestock Services, to ensure that climate change adaptation is addressed proactively and from an agricultural perspective. Building institutional and technical capacity also provided the MOAD with a comparative advantage in representing the agriculture sector in national-level adaptation initiatives facilitated by the Ministry of Environment. The case study provided recommendations to the Government to further advance climate change adaptation in agriculture sector.

1) **Additional efforts are needed to mainstream institutional and technical capacity development activities within MOAD.** At present, capacity building activities are fragmented and insufficient to meet the needs of the large DOA and Department of Livestock Services staff at the national and district levels. Currently, capacity development activities are mainly at the national level, with selected participants from the districts; capacity development at the district level is usually related to the preparation of district disaster risk management plans (DDRMPs). Farmers receive specific training programmes on improved agricultural practices as part of field demonstrations. The sustainability of MOAD capacity development activities at the national and district levels is limited due to the frequent transfer of staff members, and there are very limited efforts to strengthen the capacity of agricultural service centres.

2) **Data and information about climate change impacts and vulnerabilities must be systematically assessed and managed to help develop adaptation strategies for agriculture.** Existing assessments focus on current risks and employ a livelihood perspective to assess location-specific risks and vulnerabilities. As climate change scenarios become increasingly available, model-based impact assessments in line with the NAPA priorities will provide objective vulnerability, risk and impact assessments to facilitate implementation of the adaptation practices identified through the NAPA process.

3) **Currently available weather and climate information and early warning systems offer some opportunities, but are insufficient for managing climate risks proactively.** The risk management approach focusing on farm management strategies can enhance the adaptive capacity and resilience of farmers to the anticipated future impacts of climate change. Building on existing weather and climate information, innovative information products tailored to the needs of local farmers can increase lead times for flood and drought warnings, facilitating farmers' decision-making and improving their choice of crops and other management practices. Ongoing efforts seek to enhance the capacity of agricultural support services and local organizations to understand climate change impacts, vulnerabilities and adaptation. However, further efforts are needed to develop the current 24-hour forecasts into longer-term forecasts, which would help to expand the scope of weather and climate information from its current focus on life saving to include better safeguarding of people's livelihoods.

4) **Climate change adaptation interventions must focus on community needs.** As climate change impacts and adaptation are location-specific, interventions for the local level require the introduction and demonstration of innovative adaptation options through a guided learning-by-doing process at the district and community levels. The community-based adaptation approach has been tested

through the FAO Technical Cooperation Programme project, and efforts are now needed in all risk-prone districts to disseminate locally adapted, innovative and gender-sensitive technologies for climate change adaptation in the agriculture sector. This process will enhance local awareness of adaptation to climate variability and change and resilience to the impacts and unpredictability of current climatic extremes. As MOAD is participating in ongoing community-based adaptation initiatives, its agencies are well placed to scale up climate change adaptation and climate risk management and adaptation initiatives in all risk-prone districts. Climate change policy (2011) and local adaptation plan of action (LAPA) provides a basis to focus on community-level actions.

5) **Local inclusion can help communities gain access to livelihood assets, articulate their needs, and enhance adaptive capacity.** Institutions support farmers' groups in improving farming practices, but poor and vulnerable people are often excluded from these groups. Participants in focus group discussions reported that the leaders of farmers' groups are in the front line for receiving benefits, and resources are not distributed equitably to the most vulnerable communities. Experiences suggest that social inclusion and gender considerations are crucial to achieve desired impacts from climate risk management and adaptation interventions.

6) **Enhanced policy advocacy is needed to ensure the scale-up and sustainability of locally tested adaptation practices:** The technologies demonstrated by the pilot projects were either developed by or familiar to the government institutions but not to farmers. Although these practices have a climate risk management and an adaptation focus, they are not much different from business-as-usual agricultural technologies. There are many practices proven to reduce the climate risks significantly and enhance the opportunities for yield increase. Some practices were adopted through observation by farmers, but interventions have not yet been scaled up. The resources are not enough for immediate replication by district authorities, which lack both institutional and technical capacity. Future interventions can make use of tested practices for replication with additional resources from donor agencies and the government.

7) **Poor coordination and linkages among CBOs, NGOs and government organizations are a major impediment to advance risk management and adaptation.** Institutions and development partners at the local level work in isolation although there are ample opportunities for working with other institutions to share lessons and use resources for synergy. For example, improved coordination and collaboration between the District Forestry Office and the District Livestock Service Office (DLSO) can enhance outcomes of the grazing land and pasture improvement programmes in forests. Similarly, at the village level, coordination between CFUGs and WUAs can improve efficient use of forest resources and enhance the potential for improving the livelihoods of both women and men in risk prone areas.

8) **Increased commitment to climate risk management and adaptation at the national level will offer opportunities for building resilience in the agriculture sector.** Climate variability and climate change concerns have not yet been fully integrated into Nepal's agriculture policy and planning processes. Despite activities implemented by the government and NGOs, dedicated and predictable budget allocations for climate risk management and adaptation to climate change in the agriculture sector are lacking. FAO's technical assistance has promoted opportunities for aligning agriculture sector plans with the NSDRM and the NAPA, including by facilitating national consultations and providing technical support for preparation of the ten-year PFA. The government is committed to implement the PFA, but continuing efforts are needed for systematically addressing all the priorities through government funding and donor support.

Case Study 3: Improving livelihood opportunities through Agroforestry in Lesotho

In many parts of southern Africa, agricultural production is stagnant or even in decline, particularly in subsistence and smallholder agriculture. The reasons are many, but include lack of suitable inputs for production, environmental constraints and degradation, inadequate agricultural infrastructure, external

shocks including volatile markets, and social stresses such as the impacts of HIV/AIDS and growing poverty. As an additional stressor, increasing climate variability and climate change are impacting on agricultural livelihoods since resource-poor farmers are unable to cope with multiple stressors or adapt to climate-related risks. The Kingdom of Lesotho is a typical example of a country considered highly vulnerable to climate-related challenges: as one of the least developed countries (LDCs), it is over-reliant on rainfed agriculture for food production and has a large poor rural population engaged in subsistence farming, which is relatively undiversified.

Vulnerability in Lesotho is characterized by high population pressure on the available arable land and natural resources, fragile and substantially degraded soils, high levels of food insecurity and poverty, and lack of infrastructure which curtails the ability of the population to deal with severe weather conditions. Lesotho prepared the National Adaptation of Programme of Action (NAPA) to respond to the immediate needs of addressing the country's vulnerability to climate change. In response to Lesotho's request to assist the country to understand its key vulnerabilities, and identify and prioritize locally relevant adaptation strategies, FAO implemented an adaptation project in 3 vulnerable livelihood zones between 2009 and 2012.

This case study provides an overview of what climate change will mean to subsistence and smallholder farmers in Lesotho, and how the capacity for climate change adaptation in agriculture can be strengthened, focusing on selected areas of crops, livestock and forest-based livelihood systems, to stabilize and improve yields. The experiences and lessons learned from a pilot FAO/Government of Lesotho project are drawn, and recommendations are made for possible scale- up to other parts of the country[4].

Community level coping strategies: The people of Lesotho have evolved within a specific climatic context and a range of coping mechanisms have served them well in the past. However, rapid socioeconomic changes and environmental degradation have disturbed their ability to deal with shocks. Some coping mechanisms may no longer be effective or even desirable, and new ones are arising or becoming necessary but unachievable without programmatic assistance.

The baseline surveys revealed that farmers in the mountains and lowlands are currently doing very little, and claim to have few options for adapting to climatic-related stresses or recovering from their impacts. Drought was consistently reported by all communities to be the main stressor. It is seen as the reason for low yields or total crop failure, forced late plantings, increased fallow land and degraded rangelands, hence inadequate animal nutrition leading to less productive livestock. When farmers were asked what they would like to do to protect themselves better and adapt to a changing climate, a number of options emerged, including agroforestry, household water harvesting, the use of drought-tolerant crop varieties, increased production of poultry and pigs, and the building of shelters for livestock, amongst others.

Farmers were clear on what they perceived to be their technology needs, including the provision of improved seed (tolerant to drought and pests and of short cycle), and in the southern lowlands a request for access to implements for better ploughing and planting, manure/fertilizer for improved yields, and irrigation technology. In the lowlands, no understanding was shown of the probable acceleration of land degradation which implementation of these conventional practices would bring about. In the mountains, access to tractors was not rated highly; the reason being given that it would accelerate erosion. By far the main perceived hindrance to achieving their aspirations and accessing these technologies (albeit misguided in some cases) is the high prevalence of unemployment and poverty, and lack of financial capital. Thus, people place a high priority on higher levels of education, which they believe will increase their chances of employment, salaried jobs, ability to diversify agriculture, and generally broaden their chances of livelihood improvement.

Pro-active actions, although few, include implementation of erosion control through tree planting, irrigation of household vegetable gardens through various water harvesting technologies from small community dams to household roof water harvesting, the application of pesticides to prevent pest outbreaks, gradual shifts to demand led extension services, the use of inputs to strengthen crop growth and survival, and the shifting of

[4] FAO (2011) Strengthening capacity for climate change adaptation in agriculture: experiences and lessons from Lesotho. FAO, Rome, 66p.

the date of planting by some farmers to coincide with changing rainfall patterns (only viable in the lowlands where the season is longer).

The communities recognize the importance of crop irrigation as a response mechanism to droughts, but little has been done to attempt some form of implementation. Although potential access to low input and low cost systems, such as gravity fed irrigation and treadle pumps exists, the only irrigation practised is on a very small scale in homestead vegetable gardens. Some households are not aware of assistance, from the Ministry of Forestry and Land Reclamation, for the construction of roof water harvesting tanks. The Ministry provides cement and knowledge, while the farmers have to contribute labour and stones. If implemented, this facility would take care of irrigation needs around the homesteads. It should be noted that awareness of water conservation and demand management approaches was lacking; this needs to be addressed before supplemental approaches are considered.

No clear responses with respect to livestock are evident, other than vaccinations during disease epidemics. Livestock farmers claim that they have few options for coping with the impacts of erratic weather and recurring droughts. The average number of cattle owned per household is four or less, four being the minimum draught requirement. Thus, incidental sales of cattle (off take) for meat, cash or cultural purposes are not readily achieved. Similarly, small average flock sizes of sheep and goats do not easily allow for incidental sales or slaughter of small stock. However, in one lowland sub-catchment (Mabalane), small-scale production of dual purpose chickens takes place based on reasonable market demand.

The indigenous cattle breeds of Lesotho have endured the test of time and are highly adapted to drought and spells of extreme low temperature and snowfalls. They are multifunctional, being used for draught power, milk and meat production, and ritual functions. Livestock farmers have seen no need to change to exotic breeds – in fact, national experts believe that the indigenous cattle breeds only require optimization of herd management to express their full adaptive and production potential. However, farmers are not culling undesirable animals, so that improvement is difficult and the grazing pressure on the rangeland persists, which is compounded by climate change. Similarly, sheep and goats supply both wool/mohair and meat, and are well adapted to Lesotho's harsh climate. There is, however, a moderate systematic breeding programme for small stock and an annual ram replacement programme using hardy breeds from South Africa.

Communal rangelands are badly mismanaged, the range vegetation cover is extremely low and being replaced by unpalatable species and severe erosion contributes to loss of productive land. Nowhere is this more starkly visible than in the fence-line comparison between the Lesotho side of the Mabalane sub-catchment and the South African farmlands across the border. Range management practices are not strategically planned to respond to recurring drought, resulting into low livestock conception and birth rates. In the mountain sub-catchment, severe overstocking on limited rangeland subjects animals to highly stressful conditions resulting in very high mortality rates especially of young animals. There are a high proportion of unproductive animals which should be culled, but owners are unwilling to do this. In the lowlands, animal numbers are not currently high but still exceed the very low carrying capacities of the available rangelands, making range rehabilitation and regeneration all but impossible.

The old practice of transhumance, whereby grazing animals are moved to the cattle posts during the summer months and brought back to the local rangelands during autumn and winter months, contributes to the severe degradation and has been all but impossible to discourage. This is possibly a good example of adaptive practices which have evolved historically becoming "mal-adaptive" under the new conditions. No effort is made to produce and preserve fodder in adequate quantities to sustain animals during cold winters and dry spring months. Fodder production is seen only as a supplement for livestock nutrition, and not for the reduction of pressure on the rangeland.

A reasonably high level of awareness (but not technical knowledge) exists around the benefits of agroforestry, but existing tree planting activities could be stepped up considerably. Some of the agroforestry systems or technologies adopted by farmers in southern Africa have been used for many decades, and not necessarily because of climate variability, but because they are traditional systems that have been used for

subsistence for a long time (Maliehe, 2010). However, it appears that some of these traditional agroforestry systems have managed to withstand climate variability quite appreciably over the years, thus they could become effective responses in the face of climate change.

Moving towards integrated action for adaptation: This understanding of the impediments to adaptation leads naturally to the question "What needs to be done?" for each set of farming communities. Strategies for strengthening adaptation capacity must acknowledge the communities' stated needs and aspirations and align these with targeted innovations to create resilience and sustainability. A holistic approach is required, taking into account factors critical for the development of rural livelihoods.

Essentially, the main barrier of poverty must be addressed, and farmers should be guided to gradually re-orientate their farming approaches to be resilient to the eminent impact of climate change in fragile and highly vulnerable production system. It is highly debatable whether commercialization (which could involve moving into large-scale production) would be economically and environmentally sustainable given that the average land holding size is 1–2 ha per household and a considerable area of the country is mountainous and highly degraded.

Sustainable crop intensification on some crops (i.e. maize) in the lowlands, with clear principles of environmental conservation and livelihood diversification, would be a more viable strategy in this country that largely depends on its water resources. Policy-makers support adaptation by promoting farmer education and improving their access to climate forecasting, by investing into research that target the development of farm-level climate adaptation technologies, and also by opening access to credit and developing markets. Furthermore, these recommendations should be considered even more attentively in areas where rainfed farming currently predominates.

Technical responses (husbandry) require support by transitional government assistance through infrastructure development, subsidies, and credit and marketing facilitation. Infrastructure needs include maintenance of roads, networks to ease service and goods delivery, irrigation infrastructure such as the provision of immovable equipment, dam construction, installation of wind and solar energy systems for the exploitation of groundwater resources, and agricultural business centre establishment in villages. These centres should provide improved access to inputs and marketing outlets where farmers can sell as well as process their produce. Implements and spare parts could be available in various ways from the depots. Implements could be stored here for sale or kept for community use based on agreed arrangements. Not only crop produce should be handled here, but also that of livestock.

All programmes aimed at strengthening agriculture and developing resilience must include some form of organized credit provision. Donations and grants are fundamentally handouts that should not be viewed as viable options in support of climate change responses. The credit facilities that already exist amongst these communities are weak and should be strengthened and modified where necessary. The modification will serve to facilitate co-existence of the informal mechanisms with more formal mechanisms such as revolving funds.

Development of intensive pig and poultry enterprises is impossible without sustainable credit facilities. *Stokvels* are important gatherings to raise funds that can be used to develop agricultural businesses. Experience has shown that for crop production, cooperatives are the best option for smallholders to support their transition to commercial agriculture. Cooperatives should be encouraged from the beginning, to facilitate a smooth transition from project to autonomous community managed programmes. Community-based organizations also play a role in defining common problems and taking advantage of new technologies.

From the discussions with these farmers, the need for training emerges very strongly. Training should be broad and holistic to cater for a wide range of coping mechanisms. Training must not be confined to new coping mechanisms, but should also focus on basic sustainable crop and livestock husbandry practices which are lacking. Training of district technical staff is essential since they will in turn train the farmers. A lack of staff capacity in terms of numbers and knowledge/skills was observed. However, direct training of farmers

by professionals is not recommended since it may interfere with the agricultural extension service delivery. Clearly, the extension service requires considerable strengthening.

In addition to technological responses to climate variability and change, provision of need based localized weather and climate information to the farmers can benefit pro-active risk and opportunity management. The need-based information can enhance the potential opportunities during good seasons and reduce the risks of yield loss and crop failures during bad seasons. The availability of forecasts to vulnerable farmers could contribute to improved management of climate variability in the short term and increase adaptive capacity in the long term. Significant opportunities exists within the current institutional mechanisms if the currently available forecast products from the Lesotho Meteorological Services (LMS) are properly interpreted and made available to the farmers for decision-making. Currently, Lesotho Meteorological Services provides daily forecasts for selected locations within the country, weekly synopsis, four-day forecasts and seasonal climate outlooks produced through the regional seasonal outlook forums. Integrating the recent improvements in prediction in different time scales can advance farm level adaptation to climate change.

Agroforestry: In Lesotho, agroforestry programmes have existed for decades, driven by the Government or NGOs such as CARE Lesotho and the Rural Self-help Development Association (RSDA). While some short-term successes were achieved, most of these programmes eventually failed. Reasons are numerous and include lack of sustained technical support (e.g. extension), lack of simultaneous market development (e.g. for fruit), and project termination and withdrawal of support and subsidies. The use of trees for soil conservation and donga (gully) reclamation has achieved good results in some sites, as has the establishment of woodlots, and protective hedges and live fences around homesteads and home gardens. Both food and non-food, including fodder tree species and trees for fuelwood and construction material, have been used.

Thus there is a substantial body of work that has been undertaken on agroforestry development and promotion in Lesotho in the past. This could be a good starting point for the further advancement of agroforestry in the country, not only in terms of climate amelioration, but also as a means for communities to improve their livelihoods and food security through the multitude of products and services it can provide.

Lessons learned from the past should inform a more sustainable approach. A number of agroforestry systems have been identified which hold much potential for the improvement of livelihoods. These systems have been shown to be effective in meeting the various basic needs of communities elsewhere in southern Africa and further afield, as well as in a few cases in Lesotho. The selection of appropriate agroforestry systems is usually based on existing practices, climate, soil conditions, the level of soil erosion, livestock population, availability of pastures, household food supply and nutrition, and fuelwood requirements.

Agroforestry makes specific demands when applied to the mountains or lowlands, and will require locally adapted systems. Features of the mountains to bear in mind include the increasing land degradation and decreasing carrying capacity of the rangelands, and the severely cold winters, often accompanied by strong winds, snow and frost. Since most fast growing tree and shrub species do not tolerate these conditions, there are very few or no trees to shelter or protect livestock from the cold, and there is very little in the form of fuelwood for the local communities to warm themselves. The southern lowlands are the driest and warmest areas in the country, and overgrazing has led to significant land degradation and soil erosion. The population density is high, placing great pressure on natural resources (notably trees of all ages), and there is an acute shortage of fuelwood. In the recent past many houses in the lowlands have been damaged, with roofs blown away by strong winds, giving rise to urgent calls for windbreaks. The agroforestry systems recommended are as follows, and are supported by identified species suitable for each zone:

- **Homestead gardens and orchards:** this system has the advantage of being practiced within the homestead where young trees can be monitored and protected relatively easily from damage by livestock. It involves the establishment of small orchards or the scattered planting of individual fruit trees in the home garden, inter-planted with various vegetables. In the mountains, fruit species that can tolerate the climatic conditions can be used e.g. stone and pome fruit, and nut species. The same

species, and in addition figs, pomegranates, grape vines, mulberries, Citrus species, and appropriate olive cultivars are suitable for the lowlands.

- **Windbreaks:** establishing windbreaks in the mountains may be more difficult than elsewhere due to the very cold winters and the short growing season, and requires a long-term perspective. It may also be preferable to establish windbreaks around homesteads and homestead gardens rather than around fields, for protection of homes and gardens against cold, strong winds. Windbreaks may also protect the soil against wind erosion.

- **Hedges and live fences:** problems of trespassing are much higher in the lowlands than the mountains, but in both regions it is advisable to establish protective hedges and live fences around the homesteads, especially against livestock kept within the village but also trespassing humans. A number of species are suitable for live fencing, including *Agave americana*, which can also be used for fencing in livestock near the homestead. *Agave* has the added benefit in that it is used in the production of medicinal products, and its large inflorescence is eaten by livestock.

- **Fodder banks/trees on contour strips in cultivated fields:** this system is more applicable to the southern lowlands where grazing resources are poor. In arid and semi-arid areas of Africa, leaves and edible twigs of trees and shrubs can constitute well over 50 percent of the biomass production of rangeland. At high altitudes, tree foliage may provide over 50 percent of the feed available to ruminants in the dry season, branches being harvested and carried to the animals. Even in regions of higher rainfall where grass supplies the major proportion of the dry matter eaten by ruminants, tree leaves and fruits can form an important constituent of the diet, particularly for small ruminants. These trees could be planted in rows intercropped with herbaceous annual or perennial fodder crops.

- **Donga (gully) rehabilitation:** the extent of soil erosion in the southern lowlands is critical. Some erosion control and donga reclamation work has taken place in parts of these areas but much more work is required. A combination of tree, shrub, grass and herbaceous plant species may be used. Willows and poplars, amongst other species, can be planted on the donga floor where there is likely to be sufficient moisture to support tree establishment.

- **Beekeeping:** there are already a number of beekeepers in the lowlands, although the practice needs to be more organized. Indications are that many more lowlands farmers are willing to embark on beekeeping as a business. At the pilot site Thaba-Tšoeu Ha Mafa there are probably enough flowering plants to justify the starting up of beekeeping on a pilot basis. Suitable species include the fruit trees recommended for home gardens and several *Eucalyptus* species. They should ideally be drought tolerant.