AGROBIODIVERSITY CONSERVATION AND USE IN ASIA, PACIFIC AND OCEANIA REGION

LS Sebastian, D Chandrabalan, KH Borromeo, Z Zhang and PN Mathur
Bioversity International, Asia, Pacific and the Oceania (APO).
PO Box 236, UPM Post Office, 43400 Serdang, Selangor, Malaysia

ABSTRACT

The Asia, Pacific and Oceania (APO) region is the centre of diversity of many important species of crops, animals and livestock. Most of its resource-poor farmers depend on this agrobiodiversity for food security and livelihood. Agrobiodiversity in APO has served as the source of genetic materials that propelled the Green Revolution in the region. It has enabled continuous growth in productivity, allowing agriculture to cope with declining yield, emergence of pests and diseases and occurrence of abiotic stresses like drought and floods. Agrobiodiversity is also being explored in developing climate change ready crops for the future. In recent years, this agrobiodiversity has been threatened due to simplification of ecosystem and species, and planting of a few preferred varieties. Several countries have thus initiated programmes focusing on collecting, characterizing, evaluating, documenting and conserving the region's extant crop diversity. Approximately 900,000 accessions of the most important crops including wild relatives have been collected and maintained. However, these were not exhaustive. APO countries vary in their capacity to implement national genetic resource programmes, with 18 out of 45 countries having at least some kind of national coordination system. This has led to a situation where the collections are there but may not be viable anymore and hence can be lost forever. Nonetheless, APO's genetic resources are underutilized, with only a small portion of agrobiodiversity being used in genetic improvement programs or in agriculture. There are still many constraints to the greater use of genetic resources including the continuing under-investment in this area. To promote collaboration on the conservation and sustainable use of genetic diversity in APO, Bioversity International (formerly the International Plant Genetic Resources Institute, IPGRI) organized regional and crop/plant networks. Recently, the different networks have been tapped by the Global Crop Diversity Trust (Crop Trust) in developing and implementing the regional strategy for conservation and utilization of crop diversity. Bioversity in APO is primarily responsible in coordinating the implementation of Bioversity's global programs aimed at improving livelihood, food security and better nutrition through conservation and utilization of genetic resources. The national programmes of member-countries are Bioversity's main partners in programme implementation. To respond to the aforementioned challenges these activities need immediate attention in the region: 1) review of priorities, 2) strengthen network collaboration, 3) enhance capacity development, 4) strengthen germplasm exchange and quarantine procedures, 5) promote use of new methodologies, 6) improve information and documentation system, 7) increase focus on underutilized crops, and 8) promote Global Plan of Action (GPA) implementation.

Keywords: Agrobiodiversity, genetic resources

INTRODUCTION

The United Nations, concerned with the continued loss of biological diversity and its economic, social, environmental and cultural implications, including the negative impacts on the achievement of the MDGs, declared 2010 as the International Year of Biodiversity during its 61st General Assembly session in 2006. The declaration hopes to bring greater awareness to the importance of biodiversity by promoting the different initiatives that can reduce current rate of loss occurring globally.

A very significant part of general biodiversity is agricultural biodiversity, which is made up of all the biodiversity, managed and unmanaged, that is necessary for food and agriculture. Agricultural biodiversity, also known as agrobiodiversity or the genetic resources for food and agriculture, is the result of natural selection processes and the careful selection and inventive developments of farmers, herders and fishers over the millennia. Many people's food and livelihood security depend on the sustained management of various biological resources that are important for food and agriculture. Agrobiodiversity includes:

- Harvested crop varieties, livestock breeds, fish species and non-domesticated (wild) resources within field, forest, rangeland including tree products, wild animals hunted for food and in aquatic ecosystems (e.g. wild fish);
- Non-harvested species in production ecosystems that support food provision, including soil micro-biota, pollinators and other insects such as bees, butterflies, earthworms and greenflies; and
- Non-harvested species in the wider environment that support food production ecosystems (agricultural, pastoral, forest and aquatic ecosystems).

Agrobiodiversity is very important in the quest to adapt to climate change. Farmers will need crop varieties that can adapt to the new climate and changing environment conditions such as higher average temperatures, increase numbers of extremely hot days, shorter growing seasons, higher solar radiation, much greater moisture stress, added salinity from salt water incursion and badly managed irrigation, and new combinations of pests and diseases. Genetic resources enable plant breeders and farmers to incorporate adaptive traits into new varieties and ensure the adaptation of agriculture to climate change. These resources will have to be widely conserved in genebanks, and effectively utilized for agricultural development.

IMPORTANCE OF AGROBIODIVERSITY IN APO

The Asia Pacific region is the centre of diversity of many important species of crops, animals and livestock. Resource-poor farmers in the region are hugely dependent on the agrobiodiversity of minor crops, wild relatives of crops and wild species of plants and animals for food security and livelihood. The region stretches from Mongolia in the North to Tasmania in the South, and from India in the West to the islands of Micronesia in the East. This vast region encompasses about 45 countries and includes half of the world's population. Needless to say, the region displays a wide variety of climatic, eco-geographic and agro-ecological conditions with a corresponding richness in biodiversity amongst the flora and fauna. The Mongolian tundra gives way to highlands and semi-arid tropics and then to humid coastal plains, with climates varying from sub-temperate to tropical. This variety of natural conditions has produced great genetic diversity in crops and forest species, as well as wild crop relatives, increased by the long history of intensive agriculture in the region.

Another factor contributing to the enormous diversity found in cultivated plants in APO is the rich mosaic of people and cultures found in the region, each of whom has been selecting and using genetic resources to suit their particular needs for hundreds of generations. Population migration and trade have introduced new species and varieties that were subsequently adapted to local conditions and bred with local varieties. Domestication took place in four main areas. Crops such as eggplant (*Solanum melongena*), pigeon pea (*Cajanus cajan*), black pepper (*Piper nigrum*) and jackfruit (*Artocarpus heterophyllus*) originated from the Indian centre of diversity. Soybean (*Glycine max*), onion (*Allium cepa*), cabbage (*Brassica oleracea*), peach (*Prunus persica*) and foxtail millet (*Setaria italica*) developed in the Chinese centre. Oriental rice (*Oryza sativa*), banana (*Musa* spp.), citrus (*Citrus* spp.), mango (*Mangifera indica*), yam (*Dioscorea* spp.) and taro (*Colocasia esculenta*) emerged from Southeast Asia. Coconut (*Cocos nucifera*) and breadfruit (*Artocarpus altilis*) originated from the Pacific Islands. Many underutilized crops that are of localized importance in the region show a great diversity at the species and genetic level. The same is true for tropical fruit species. Additionally, the genetic diversity in both indigenous and introduced species has been enhanced through extensive exchange of material within the region.

This agrobiodiversity, however, has been threatened in recent years due to simplification of ecosystem and species, and the planting of a few preferred varieties. Monocropping and the use of genetically uniform livestock and poultry breeds have contributed to the loss of many traditional local varieties/breeds. The loss of habitat resulting from the reduction in forest cover, coastal wetlands and other wild, uncultivated areas has also contributed in the loss of many wild relatives and wild species. The services that these ecosystems provide to agriculture, for example pollination and pest management, are simultaneously lost. Lastly, much of the traditional knowledge on biodiversity has been largely ignored and is fast disappearing. This traditional knowledge (TK) embodies the coping mechanisms of local people under varied and rigorous circumstances that make unique areas productive and sustainable. TK is thus important in conservation and sustainable use of biodiversity.

CURRENT STATUS OF AGROBIODIVERSITY

Several countries have exerted significant efforts in collecting, characterizing, evaluating, documenting and conserving the crop diversity extant in the region, through its national programmes. Approximately 900,000 accessions of the most important crops, including wild relatives, have been collected and maintained by the countries (including those in the genebanks of IRRI and ICRISAT) in the region. However these are not exhaustive.

The countries in the region vary in their capacity and capability in implementing national genetic resource programmes. Eighteen out of 45 countries have a national coordination system stronger or weaker than others. For instance, Bangladesh, Bhutan, China (including Taiwan), India, Indonesia, Japan, North Korea, South Korea, Malaysia, Mongolia, Myanmar, Nepal, New Zealand, Philippines, Papua New Guinea, Sri Lanka, Thailand and Vietnam have a national level coordination of activities. Meanwhile, Australia, China, India, Japan, New Zealand and South Korea have well established national programmes. Also, the lack of adequate facilities and human capacity to manage the collections properly has lead to a situation where they may not be viable anymore and hence can be lost forever.

South Asia

The South Asia region is very diverse in terms of agro-ecology, flora and fauna, climate, and ethnicity. The Hindustani (Indian subcontinent) Diversity Centre harbors 166 cultivated plants species (Zevan and de Wet 1982). It has rich variability in wild relatives of crop plants. In India alone, 320 species of such wild relatives have been listed (Arora and Nayar 1984). Important resistance genes that helped managed serious pest and disease outbreaks have been transferred from wild relatives such as *Oryza nivara* (brown leaf hopper), *Oriza rufipogon* (grassy stunt virus resistance) and Cucumis species (powdery mildew resistance).

Rice, wheat, sugarcane, pulses, oilseeds, maize, millets, potato and vegetables are some of the main food crops cultivated in South Asia. In this area, the agricultural landscape is gradually transforming from subsistence production system to commercial agriculture. Under the traditional subsistence farming practices, crops produced are mainly for household consumption and the surplus, if any, are sold in the market. The importance of traditional cash crops (jute, sugarcane, tobacco, etc.) has diminished over time as farmers now turn to food crops like rice, wheat, fruits and vegetables for commercial production and income. Traditional dependence on a vast variety of grains and cereals has also caused a skewed dietary pattern in its food basket.

Being one of the world's largest and oldest agricultural societies, much of the day to day lives of India's 1.1 billion population are governed by the agriculture sector. India still holds a wealth of native plant genetic resources (PGR) that includes about 800 species of ethnobotanical interest and about 1200 species of medicinal plants. Crops with rich diversity that still exist include: rice, wheat, barley, sugarcane, forage grasses, legumes, several Brassica species, okra, eggplant, Citrus, Musa species, jackfruit, mango, jute tree cotton, ginger, turmeric, pepper, cinnamon and cardamom. Among tuber crops, rich variability exists for sweet potato, taro, and yam. Rich diversity also exists in several tree and forestry species like bamboo and rattan (Rana and Chandel 1992). The concentration of genetic diversity comprising native species and landraces are found in the Western Ghats, Deccan Plateau, central India, North-Western Himalayas and North-Eastern hilly region of India.

Similarly, Nepal's population remains largely agrarian, with about 80% of its 27 million people working in agriculture. More than 95% of farmers rely on seeds that are selected, stored and exchanged within the traditional agronomic and socio-cultural practices of farming communities (Joshi, 2000). Though it is home to more than 2,500 landraces of rice, only 43 improved varieties of rice have been released and in addition, rather poorly adopted by farmers. One problem is that only 2 of the 43 varieties released were recommended for high altitudes. High altitude rice is grown at elevations from 1500 to 2000m, and cover 26% of the 1.5 million ha of rice land (Sthapit and Subedi, 2000).

In Bangladesh, the number of modern varieties is increasing, at the same rate that traditional varieties are decreasing. There are more than 160 crops grown in Bangladesh, and about 300 wild indigenous species of plants identified as relatives. Reasons for diversity loss include: the use of high-yielding crop varieties at the expense of traditional varieties/landraces, lack of knowledge of multiple use of species, lack of value addition as well as overexploitation of plant genetic resources.

It can be surmised that agrobiodiversity remains the backbone for the sustainable development of agriculture, food security and poverty alleviation for most countries in South Asia.

Southeast Asia

Southeast Asia is home to seven of the 25 world's biodiversity hotspots and three of the 17 megadiverse countries (Indonesia, Philippines and Malaysia). The sub-region's long geological history has contributed to its varied landscapes, water bodies and climatic conditions, giving rise to high species diversity. Like its more developed neighbours, countries like Cambodia are now driven towards being more market-oriented and slanted towards the open economy system. This has led to increased urgency in rebuilding and inventorizing genetic resources knowledge. But this move is a threat in itself - using agrobiodiversity to fuel a market-oriented economy could lead to severe environmental damages.

Crop cultivation in the region depends largely on a few traditional cultivars, old varieties and landraces. In Cambodia, almost 80% of the area is cultivated with local unimproved varieties of rice, maize, sesame, vegetables and potatoes. In countries like Laos which were once rich in biodiversity, agrobiodiversity is fast declining due to inappropriate farming methods, excessive grazing of community grassland, over-exploitation of forest resources and non-timber forest products, monoculture plantations of maize, cassava, tea, teak and rubber and the encroachment of forests and farmlands because of competing land-uses, including industrial agriculture and forestry. The rural people are most vulnerable to this declining biodiversity, degraded environments and changing climate. Urgent action is therefore needed to simultaneously improve people's livelihood and safeguard the remaining biodiversity in the country.

In Malaysia, agrobiodiversity is threatened directly or indirectly by human activities that interfere with the habitat, such as land development, which involved the conversion of agriculture areas into non-agriculture areas and non-selective harvesting. Added to this is the introduction of new crop varieties, natural disasters and biotic and abiotic stresses, and natural rarity. Other reasons for agrobiodiversity loss include over-exploitation (wild fruit trees), population growth, in-migration, current global popularity of herbal medicines, negative market influence, and lack of funds for biodiversity conservation. Most of the landraces of vegetables and rice are under threat due to the introduction of modern, more uniform varieties. In Vietnam, rice prevails as the dominant crop planted in over 80% of the total farm lands and providing above 90% of the nation's total food grain output. The country is the world's second rice exporter, after Thailand. In 2006, the national total rice production was 39.65 million tons, of which four million was exported. The Government of Vietnam has thus pushed for income diversification by increasing farmer's interest in other important food crops such as maize, sweet potato, cassava, legumes, soybean, fruits and vegetables. As a result of programmes for agricultural promotion and diversification, small-scale farmers have successfully increased their crop yields, and income. Farmers have also attributed rising income to growing more profitable crops such as litchi, tea, sugar cane and tobacco.

East Asia

The crops grown in the sub-region include rice, wheat, corn, soybeans, sorghum, barley, millet, peanuts, pulses, sugar beets, potatoes, cotton, oilseeds, forages, root crops, vegetables and fruits. East Asia is one of the major diversity centres of crop species in the world. More than 300 cultivated species and wild relatives originated in this region and many of them are of global importance, such as soybean, rice, wheat, citrus, oat, barley, buckwheat, Chinese cabbage, adzuki bean and tea. Rice has been cultivated for over 7,000 years and has become one of the major food crops in East Asia. Considerable diversity of cultivated species was also created due to their long history of cultivation and diverse eco-geographical environments. For instance, in China, 600 species of 200 crops are cultivated. There is also a significant diversity in forest species such as *Polulus, Salix, Paulownia, Castanea, Phyllostachys,* bamboo*, Metaseguoia* and many conifers (*Abies, Cryptomeria, Larix, Picea* and *Pinus*) (FAO 1996).

The loss of agrobiodiversity in the sub-region has also been extensive in view of rapid economic development and changing agricultural practices. In Korea, the number of plant varieties cultivated in small gardens has been reduced by more than 75% in the period from 1985 to 1993. In China, nearly 10,000 wheat varieties were used in 1949, but only 1000 in the 1970s. Fifteen million hectares of hybrid rice in China share a common cytoplasmic male sterility source. Indigenous genetic resources of food and agricultural produce in Japan are said to be few. Nevertheless, crops such as wasabi (Japanese horseradish) and other spices and herbs used in traditional Japanese cuisines, heighten the concern for the efforts needed to be strengthened in managing agrobiodiversity effectively. The loss in diversity, due to meeting consumer and retailer needs, has added to the urgency in developing methods for agrobiodiversity conservation.

Plant genetic resources offer a great potential in combating poverty and contributing to economic development in East Asia countries. All these countries have made efforts to evaluate, improve and use their germplasm collections in cooperation with plant breeders and researchers. Farmers are direct users of crop landraces, particularly those of underutilized crops. Farmers also intercrop the landraces with modern cultivars to control pests and diseases in the agroecosystem.

By using local germplasm, China has developed large numbers of improved cultivars for different crops including wheat, rice, maize, sorghum, millet, soybean, peanut, vegetables and fruits. In Japan, emphasis has been given to improving agronomic characteristics such as resistance to pest and diseases, and cold stresses, and grain and eating quality, by using genetic variation in local germplasm collections, including wild species. Recently, state-of-the-art technologies such as gene transfer and recombination of DNA are being considered for using germplasm in breeding programmes.

Pacific

The varied growing conditions spreading across the 22 island states of approximately 20,000 islands attribute to much of the diversity found in agriculture in the Pacific. Taro, yam and banana take precedence as the major crops grown for subsistence living. This once rich region of unique diversity is increasingly threatened by various challenges such as lack of integrated pest management (IPM) techniques, agricultural intensification and extreme climatic conditions. A strong call for building the resilience of island communities to increase crop diversity seems to be paving its way forth with The Secretariat of the Pacific Community (SPC) taking lead on plant genetic resources activities being implemented. The setting up of the Regional Germplasm Centre (RGC), now the Centre for Pacific Crops and Trees (CePaCT) has played a major role in the conservation of valuable genetic resources and to date, holds a unique collection of 878 accessions of taro, yam, sweet potato, banana, breadfruit, cassava, kava, aibika and black pepper (March 2010).

MAJOR CONSTRAINTS TO THE GREATER USE OF CONSERVED GENETIC RESOURCES

Agrobiodiversity in APO is a source of genetic materials that propelled the Green Revolution in the region. It has enabled the region's continuous growth in productivity, allowing agriculture to cope with declining yield, emergence of pests and diseases and occurrence of abiotic stresses like drought and floods. Nowadays, agrobiodiversity is explored in the development of climate change ready crops for the future. Despite all these benefits, the genetic resources in the region are underutilized, with only a small portion used in genetic improvement programs or in agriculture. The Green Revolution itself has contributed to the narrowing of the genetic base of cultivated crops and loss of on-farm diversity due to the intensification and simplification of agriculture. Among the major constraints to the greater use of genetic resources are the following (Rao and Mathur, 2006):

1. Lack of accession level characterization and evaluation data about conserved materials. Especially on evaluation for biotic and abiotic stress traits;
2. Poor coordination of policies at the national level;
3. Poor links between genebanks and users of germplasm;
4. Germplasm access issues;
5. Lack of availability or insufficient sample size;
6. Low diversity available within collections, especially for related and wild species; and
7. Lack of awareness on the role of genebanks and their activities.

These issues contribute to the difficulty of using the available materials for genetic improvements, which is further compounded by hybridization problems (e.g. wild relatives) and longer period of breeding. Many of these issues are perennial constraints due to the continuing underinvestment on the conservation and use of genetic resources in the region.

APO'S GENETIC RESOURCES NETWORKS

To promote collaboration on the conservation and sustainable use of genetic diversity in the Asia Pacific region, several plant genetic resource networks were organized through the assistance and facilitation of Bioversity International (formerly International Plant Genetic Resources Institute, IPGRI). The networks serve as an important tool for promoting information exchange and research on plant genetic resources.

The networks are categorized into two types; regional networks and crop/plant networks. The regional networks include members from countries in a defined geographic region, generally represented by members coming from the national PGR centres, while the crop/plant networks focus on the conservation and sustainable use of a single crop commodity. Regional PGR networks usually have the common objectives of 1) sharing information and germplasm, 2) developing common positions on PGR issues and policies, human resources development and 3) strengthening of national PGR programmes through collaboration. Bioversity is participating in numerous networks in the region in various capacities, such as providing technical and advisory support. A review of Bioversity's involvement in networks showed that networks could be effective in advancing common objectives of strengthening national programmes, collaboration, developing conservation technologies, and in exchanging and disseminating information on PGR.

Four sub-regional PGR networks have been successfully operating in the Asia-Pacific Region with technical and financial support from Bioversity. These are the: South Asia Network on PGR (SANPGR), Regional Network for Conservation and Utilization of PGR in East Asia (EA-PGR), Regional Cooperation in South East Asia for PGR (RECSEA-PGR) and Pacific Agricultural Genetic Resources Network (PAPGREN). Important crop/plant networks include: International Network for the improvement of Banana and Plantain (INIBAP), Coconut Genetic Resources Network (COGENT), Asia Pacific Forest Genetic Resources Programme (APFORGEN), Asian Fruit Genetic Resources Network (AFGRN), Medicinal Plants Research Network, and Underutilized Crops Networks on buckwheat, okra, sesame, safflower, Lathyrus, taro, and sweet potato.

Recently, the different regional networks have also been tapped by the Global Crop Diversity Trust (Crop Trust) in developing and implementing the regional strategy for conservation and utilization of crop diversity in the region. Crop-based conservation and utilization strategies were also developed for coconut and banana.

The networks are important modalities in developing capacity on the implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) where many of the countries in the region are signatories.

BIOVERSITY'S REGIONAL PROGRAMME IN APO

The regional programme of Bioversity in APO is primarily responsible in coordinating the implementation of Bioversity's global programs aimed at improving livelihood, food security and better nutrition through conservation and utilization of genetic resources. To achieve this, Bioversity partners with APO countries through its national programmes. A considerable amount of work is devoted towards developing and promoting improved technologies among partners. The regional office also works with various national partners in identifying regional and national needs, priorities and opportunities for Bioversity to facilitate and add value to regional and national activities. The regional office takes responsibility in strengthening programmes of plant genetic resources in the region, as well as promoting coordination and networking

Bioversity's major partner in each country in the region is the organization within the National Agricultural Research System (NARS), with or without a specialized body for work on plant genetic resources. These organizations differ from each country. In South Asia, the Indian national system is by far the strongest partner in the region. Sri Lanka has a national level programme while Bhutan, Nepal and Bangladesh have small crop genebanks. National committees in Indonesia Malaysia, the Philippines and Thailand were formed during the late 1980s and early 1990s and help coordinate genetic resources activities. In East Asia, institutions which have been close collaborators are: the Chinese Academy of Agricultural Sciences (CAAS) in Beijing; the Rural Development Administration (RDA) in Suwon, Korea; the Plant Science Agriculture Research Institute, Darkhan, Mongolia; and the Crop Genetic Resources Institute, Pyongyang, DPR Korea. In Japan, the genebank system of 15 organizations based at the central genebank at the National Institute of Agricultural Research (NIAR) in Tsukuba is the main collaborator. With the exception of Papua New Guinea, few countries in Melanesia or Polynesia have a national programme. Australia has a well-developed and highly decentralized system. For the Pacific and Oceania, collaboration is coordinated with the Secretariat of the Pacific Community (SPC) that implements a genetic resources program and maintains a genebank.

FUTURE THRUSTS

To respond to the rapid loss of agricultural biodiversity, environmental change and the growing demands for food and incomes from agricultural production, the following activities need immediate attention in the APO region:

Review priorities:

- Re-identify national priorities for plant genetic resources (PGR) programmes, in view of the changing agricultural scenarios of increasing food demand, growing incidence of "hidden hunger", and impending impacts of climate change.

Strengthen network collaboration:

- Focus on regional issues and benefits to enhance collaborative efforts for the efficient utilization of genetic resources available in the region. Link the sub-regional network activities to broader regional or global network activities, such as Asia Pacific Association of Agricultural Research Institutions (APAARI) for enhancing sustainability;
- Emphasize network activities for under-utilized crops in the region such as: minor millets (finger millet, kodo millet, foxtail millet, and little millet), and minor legumes (black gram, rice bean, lablab bean, horsegram, etc.); and
- Enhance collaboration between national and international research institutions, such as the CGIAR Centres in the region. Jointly identify and undertake PGR related priorities and activities.

Enhance Human Resources development:

- Enhance capacity development activities in national systems through short courses and degree courses to meet the increasing demand for scientific and technical human resources and the fast development of newer technologies for plant genetic resources.

Strengthen germplasm exchange and plant quarantine:

- Assist countries that have signed the International Treaty of Plant Genetic Resources for Food and Agriculture (ITPGRFA) by developing their capacity to implement the Treaty; and
  Improve cooperation and coordination on plant quarantine issues for safe movement and exchange of germplasm.

Promote the use of new methodologies and techniques:

- Promote the concept of developing core collections of indigenous large gene pools in view of better genebank management and enhanced use of plant genetic resources;
- Develop and test methodologies for promoting pre-breeding/ germplasm enhancement for broadening the genetic base of breeding materials through utilization of wild and rare alleles;
- Develop partnership with farmers and other stakeholders to explore alternative approaches for genetic improvement such as participatory plant breeding which has been shown successful in certain situations;
- Undertake jointly with partners studies related to the assessment of genetic erosion and restoration of lost diversity across region;
- Encourage capacity development and establishment of facilities for undertaking molecular and biochemical characterization of promising germplasm resources(e.g. DNA fingerprinting);
- Promote cost effective complementary strategies for conservation of genetic resources; and
- Empower traditional maintainers of biodiversity in the region for *in situ* conservation on-farm to enhance conservation of landraces and wild relatives of cultivated crops, both in situ and on-farm. Apply modalities for community based biodiversity conservation with partners especially with NGOs.

Improve information and documentation system:

- Emphasis IT development for various PGR activities through software developments, data-interchange protocols, electronic germplasm catalogues and directories, development of InfoBase, GRIN Global and others;
- Increase emphasis on documenting traditional indigenous knowledge (TK) and link TK use in both conservation and utilization of genetic resources in the context of Intellectual Property Rights (IPR) issues; and

- Focus on public awareness activities to promote PGR conservation.

Increase focus on underutilized crops:

- Promote underutilized tropical fruit species, crops, forage and browse species, and medicinal plants of regional importance for food security, nutrition and income generation for poor farmers.
- Support core breeding activities for neglected crops is needed.

Promote Global Plan of Action (GPA) implementation:

- Promote implementation of the GPA in the region. Encourage countries to facilitate in putting in place the necessary regulatory/ legislative mechanism as required under the provisions of the Convention on Biological Diversity (CBD), World Trade Organization (WTO) and TRIPS-agreement (Trade-Related Aspects of Intellectual Property Rights) in accordance with national needs and requirements.

CONCLUSIONS AND RECOMMENDATIONS

The vast agrobiodiversity in the region has provided resource-poor farmers food security and livelihood. Agrobiodiversity in APO can also be considered as the source of genetic materials used in propelling Green Revolution in the region. It has enabled continuous growth in productivity, allowing agriculture to cope with declining yield, emergence of pests and diseases and occurrence of abiotic stresses like drought and floods.

The effective conservation and utilization of the region's agrobiodiversity is an area that needs more focus and investment at national and regional level. Most national genetic resource programmes in the region, if existent, are weak despite the fact that many of these countries are diversity hot spots. There is a dire need for continuing capacity development on the conservation and utilization of genetic resources.

Utilization of conserved genetic resources is also another area of great potential benefit but still facing age-old constraints. Investments in pre-breeding activities are required to capture new desirable traits from a wide range of crop diversity and selected materials adapted to diverse ecological conditions. Core improvement activities for neglected crops also need to be initiated. All these activities require countries to have adequate technical and economic resources for an integrated national breeding approach.

Agrobiodiversity is also being explored in developing climate change ready crops for the future. New tools (biotechnology, molecular biology and informatics) and policies for exploiting the potentials of agrobiodiversity are now available. These new tools, however, require a new alliance among scientists working in plant breeding, molecular biology, bioinformatics, biometric, and advance data management to create a network that integrates genetic resources, genomics and crop improvement information.

The regional and crop networks are important players in capacity development and in enhancing exchange of materials and their use in APO. They can work jointly with CGIAR centres to identify regional priorities and implement region-wide PGR-related activities. In addition, network activities can also put more focus on underutilized crops in the region.

Lastly, there is a need to form new partnerships with: 1) farmers' and other stakeholders', to promote participation in plant breeding activities, adoption of innovations, and usefulness of research for the poor; and 2) the private sector, to access research funds and new tools for exploiting genetic resources.

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