

REVIEWING PLANT GENETIC RESOURCES EDUCATION IN EAST AND SOUTHEAST ASIA

Proceedings of an International Workshop
held at the University of Tsukuba, Japan on 17 -19 November 2009

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Bioversity International is an independent international scientific organization that seeks to improve the well-being of present and future generations of people by enhancing conservation and the deployment of agricultural biodiversity on farms and in forests. It is one of 15 centres supported by the Consultative Group on International Agricultural Research (CGIAR), an association of public and private members who support efforts to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment. Bioversity has its headquarters in Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The Institute operates through four programmes: Diversity for Livelihoods, Understanding and Managing Biodiversity, Global Partnerships, and Commodities for Livelihoods.

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Contents

Acknowledgments	vi
Foreword	vii
Executive Summary	ix
Introduction	xii
OPENING SESSION	
Introduction	3
Welcome Address (K. Watanabe)	5
Welcome Address (L. Sebastian)	5
Global Initiative on Agrobiodiversity Education - A global update	9
SESSION 1. REVIEW OF UNIVERSITY EXPERIENCES FROM TEACHING PGR COURSES & PROGRAMMES	
Experiences from Universiti Putra Malaysia (G.B. Saleh)	17
Experiences from University of Malaya (H.B. Ibrahim)	21
Experiences from the past five years from Kasetsart University (H. Volkaert and S. Wasee)	29
Vegetable Germplasm Management at Kasetsart University (S. Wasee)	31
Experience from University of Nottingham (P.G. Alderson and S. Mayes)	35
Experiences from Kangwon National University, Korea (N.S. Kim and J.K. Lee)	41
Plant Genetic Resources Education in the Pacific (T. Kete et al)	45
Experiences from University of the Philippines Los Baños (T.H. Borromeo and N.C. Altoveros)	49
Experiences from Universiti Kabangsaan Malaysia (M.B. Osman)	53
SESSION 2. VIEWS & FEEDBACK FROM PGR STAKEHOLDERS: EMPLOYERS & STUDENTS	
International Career Development in PGR & Plant Breeding (K. Watanabe)	61
Environmental Challenges with Local Stakeholders: 3 E-forum at Tsukuba (K. Watanabe)	63
Experiences on PGR training from the perspective of genebank management (M. Takeya et al)	65
Feedback from Students: A Survey of Graduates of the Post-Graduate PGR Programme at the University of the Philippines Los Baños (T.H. Borromeo and N.C. Altoveros)	69
SESSION 3. REGIONAL AND INTERNATIONAL OUTLOOK REGARDING CONSERVATION & USE OF PLANT GENETIC RESOURCES, TEACHING & LEARNING APPROACHES	
United Nations University's experience with e-learning (B.F.D. Barrett)	77
Integrating PGR related courses into a new graduate program: the case of the programme on Environment Diplomatic Leader (K. Watanabe)	81
SESSION 4. TOWARDS A SHARED UNDERSTANDING OF THE WAY FORWARD	
Group work on internal and external drivers and influences that universities need to address	85
Strategies for curriculum change	86
Plenary discussion: Putting the plans into action	87
Closing Session	91
Visit to National Institute of Agrobiological Science (NIAS) genebank	91
<i>Annex 1. Programme</i>	93
<i>Annex 2. List of Participants</i>	95

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The Editors also wish to thank all participants for preparing the papers presented in the workshop, and for constructively contributing to the workshop discussions.

Foreword

The Asia-Pacific and Oceania (APO) region is home to some of the world's most biodiverse ecosystems. This rich diversity has underpinned the domestication of many of our globally important food and fodder plants. Several centers of origin of cultivated plants are found in the region: cereals and legumes like rice, chickpea and soybean; fruits like mango, orange and banana; oil and fiber plants like sugar cane and coconut palm are but a few of the many crops domesticated in the APO region. Crop wild relatives hold important parts of those species' genepool and are invaluable materials for breeders and scientists striving to improve food and nutritional security and adapt to climate change. Likewise, farmers' locally adapted varieties constitute an important asset. A rapid land use change affecting both 'wild' and agricultural ecosystems has led to an alarming loss of species and populations and loss of landraces grown on farmer's fields.

Breeding of new varieties and conserving genetic resources in genebanks, *in situ* and on farms are competences essential to countries' agricultural development. A sufficient number of graduates are needed every year to meet this need. The region's universities and Bioversity International's APO office therefore initiated collaboration in 1998 to assess the situation, recommend actions for strengthening PGR education, and enhance networking and knowledge sharing. Towards this end, the first regional workshop on plant genetic resources (PGR) education was held in Malaysia in 2001¹.

Since then, universities in India, Malaysia, Nepal, Philippines, Sri Lanka, Thailand, among others, have been enhancing their PGR MSc programmes guided by the recommendations from that regional meeting. Yet, there are alarming signs that enrollment in programmes specialized on PGR is very low, and that earlier scholarship opportunities have been terminated.

Meanwhile, the global scene has changed. Policy instruments such as International Treaty on Plant Genetic Resources for Food and Agriculture have entered into force. The interest in advancing management and use, and commercializing 'neglected and underutilized species' (NUS) has increased. The links between the food system and the nutrition system are being re-assessed. And, crucially, climate change is expected to have great impact on agricultural biodiversity, while at the same time agrobiodiversity holds an important key to adaptation to such change. These trend and needs motivated the organizers to convene a 2nd regional workshop on reviewing plant genetic resources education in East and Southeast Asia at Tsukuba University, Japan on 17-19 November 2009.

The proceedings of the Tsukuba workshop are presented in this document. We do hope these proceedings will inspire the regions' higher education system to not only continue improving their PGR and agrobiodiversity offerings, but also integrating such topics in a diverse range of relevant programmes and courses related to agriculture and environment.

KWESI ATTA-KRAH
DEPUTY DIRECTOR GENERAL
BIOVERSITY INTERNATIONAL

¹ Burke L, Oliver JT, Rao R, and Sajise E (Eds.) 2002. Collaboration in PGR education: Proceedings of the meeting on Postgraduate Education in Plant Genetic Resources Networking. 19-21 September 2001, Serdang, Malaysia. IPGRI

Executive summary

There is a growing awareness among citizens and governments of the importance of biodiversity in our lives. But this awareness seems primarily concerned with biodiversity in natural ecosystems such as the degradation of tropical forests, or threats to rare species such as pandas and other large mammals. An important component of biodiversity, Plant Genetic Resources (PGR) for food and agriculture, is largely ignored. This is also reflected in higher education: year after year, universities in Southeast and East Asia witness a declining number of students enrolling in PGR degrees and courses.

PGR education is crucial in tackling the needs for conservation of agricultural biodiversity, and for breeding improved varieties that can increase agricultural production and improve the quality of our food basket. By providing scientific, technical and practical skills, PGR education is an important means of capacitating countries to respond to threats of climate change, resource depletion, natural calamities and booming population. For this reason, Bioversity International is committed to mainstreaming PGR in higher education. In the late 1990s Bioversity and several of the region's universities collaborated on developing MSc programmes on PGR management and to strengthen networking on PGR education. Now, a decade later, it was timely to take stock of these experiences and to agree on the way forward.

Bioversity scientists, PGR experts, course coordinators and university professors in Southeast and East Asia met on 17 -19 November 2009 at the University of Tsukuba, Japan, to discuss solutions to the problem: How could we revitalize PGR education and make it relevant to the call of our time?

According to the reviews of universities' experiences, presented in **Session 1** of this workshop, very few students in the region specialize in PGR. Such programmes and courses attract only limited numbers of graduate students. The resulting paucity of capacity is a potential threat to national and international plant breeding programmes that rely on such competence (in contrast, biotechnology has become a popular choice among agriculture students). This downward trend is reflecting a low popularity of agriculture education generally.

Two factors behind this decline stand out: a perception among students of limited career opportunities for PGR graduates, and a reduction in scholarships available for such studies. To keep the programmes and courses running in spite of a low demand, universities find it crucial to collaborate and share resources. Another key strategy is teaching PGR within other existing programmes. For example, University Kebangsaan Malaysia has succeeded in attracting students from other graduate programmes to elect PGR courses as part of their degrees.

Although most universities are strong in human resources, and do enjoy good collaboration with national research institutes and regional networks, they are falling behind in terms of facilities and equipment. Limited access to practical training at genebanks and field site was also a constraint.

Session 2 captured the views of stakeholders in PGR education – students, faculty, local government and organizations employing PGR graduates. Two universities, the University of the Philippines Los Baños, and Universiti Kebangsaan Malaysia presented the results of two surveys of the graduates of MSc. PGR programmes. According to the students, the lack of scholarships and real job offers for PGR graduates turn them away from studying PGR. There is a need to make undergraduate students more aware of the programme and to make potential employers more aware of the benefits of hiring a graduate of the programmes. Other constraints include high costs of maintaining laboratories, lack of continuity of programmes due to low enrolment, and orientation of the PGR programmes towards the public sector and a failure to capture opportunities in the private sector. This was linked to programmes' current focus on conservation and diversity assessment, which may not be priorities of the private sector.

An example from Japan demonstrated how such issues could be addressed. A dozen universities in Japan, including University of Tsukuba, are reviewing their programmes to internationalize their education, including on PGR and plant breeding.

This session also included a presentation from the National Institute of Agrobiological Sciences (NIAS) genebank, demonstrating the competencies required to manage PGR germplasm and related information systems.

The presentations in **Session 3** gave a regional and international outlook regarding conservation and use of PGR, and on innovative teaching and learning approaches. The United Nations University in Tokyo is using state of the art eLearning tools to deliver an online Master's degree on Development Management. The programme uses a 'blended learning' approach, where students from several countries spend a few weeks together at the beginning of each year, followed by tutored online learning.

Broadening programmes and taking a multi-disciplinary focus is a way forward to increase relevance and attract new categories of students. The "MSc in Biodiplomacy" programme at University of Tsukuba is one such example.

Session 4, finally, entailed group work and plenary sessions that discussed "Towards a shared understanding of the way forward". The participants analysed "internal and external drivers and influences", suggesting that PGR can play a role in the revival of agriculture education. However, this would require renaming programmes, better connecting PGR with environmental issues, closer links with international institutions and piggy-backing on biotechnology and genomics. As for "Innovations and new opportunities for PGR training" participants noted that awareness of PGR issues is very low in some countries, Lao PDR and Myanmar being cases in point. Regional PGR networks should expand their current focus on conservation to better cover enhancing the use of PGR.

In the closing session, an **Action Plan** for enhancing PGR education in East and Southeast Asia, and the Pacific was agreed upon. Five strategies were suggested: 1. Course enhancement; 2. Enhancement of degree programmes; 3. Short courses for working professionals; 4. Networking and strengthened collaboration, and; 5. Creating awareness. The **priority action points** are highlighted in Box 1.

In conclusion, a major overhaul of PGR programme curricula is needed. Efforts to teach PGR within other degree programmes would expand the reach of PGR education. Private sector employment opportunities should be better targeted in PGR education. One way of attracting students to PGR courses is to offer e-learning and distance learning modules. Collaboration among universities in the region would greatly enhance such educational change.

BOX 1. ACTION PLAN FOR STRENGTHENING PGR EDUCATION

1. Create scholarships for MS degrees for international students
2. Broaden the scope of MS degrees to include: bioinformatics, biotechnology, genetic enhancement, genomics, gene discovery, natural products, valuation, law and policy including bio-diplomacy
3. Continue the networking on PGR education in the APO region
4. Incorporate PGR content in relevant courses, such as quantitative genetics, population genetics
5. Develop short courses/workshop for policy makers, young professionals who have not been exposed to PGR
6. Change of names of degree programmes to more attractive titles, i.e. Bio-resources sciences or Biodiversity studies
7. Improve quality of research in MS programmes by increasing number of hours, credit units and aiming for collaborative or industry-related research
8. Conduct surveys with stakeholders to determine needs for PGR competence
9. Introduce courses on entrepreneurship to show potential of PGR for wealth creation
10. Enhance degree programmes through eLearning / eTeaching on PGR.

OPENING SESSION

Introduction

Graduate programmes and courses on plant genetic resources (PGR) have been offered in several universities in South and Southeast Asia for more than 10 years. Masters' degree programmes in PGR conservation and management were first offered in India (Indian Agriculture Research Institute) and the Philippines (University of the Philippines, Los Baños) in 1997. In Malaysia, the Universiti Kebangsaan Malaysia (UKM) followed suit. Additionally, some universities have introduced courses on PGR. Others still have strengthened their current agriculture courses in terms of PGR content. Bioversity International has been instrumental in pursuing these initiatives in the Asia Pacific and Oceania (APO) region, which since has become a model for other regions.

In the past decade, scientific advances in biotechnology, and information and communication technology (ICT) have had strong implications for the offering and delivery of higher education, as universities adjust to meet society's demand. At the same time, student enrollment in traditional agriculture degree programmes including PGR graduate degrees, have declined rapidly.

The importance of conservation and sustainable use of PGR, however, has not diminished. Biodiversity in general and agricultural biodiversity in particular is increasingly threatened by population growth, rapid economic development and progress of countries and communities, and other processes that lead to decline of ecosystems services. PGR has become more important as a resource in coping with the looming threats of climate change, natural calamities, resource depletion and population increase. Hence, Bioversity International continues to collaborate with the regions' universities to pursue the mainstreaming of PGR and agrobiodiversity in higher education.

Building on experiences in the past decade, University of Tsukuba in Japan and Bioversity teamed up to organize a regional workshop on 'Reviewing Plant Genetic Resources Education in East and Southeast Asia and Oceania', at University of Tsukuba, 17-19 November 2009. The workshop aimed to share lessons and experiences in PGR education, assess new dimensions and recent developments in education approaches, and enhance networking to strengthen PGR education and make it more relevant to the needs of the time. The workshop was timely: the United Nations declared 2010 to be the International Year of Biodiversity.

Objectives and programme

General objective

The general objective of this workshop was to enhance the relevance, content and delivery of plant genetic resources (PGR) and related courses and programmes in East and Southeast Asia.

Specific objectives

- Review universities' experiences of teaching PGR courses and programmes in East and Southeast Asia in the past five years
- Share regional and international advances in the conservation and use of PGR and agricultural biodiversity
- Provide inputs and feedback from stakeholders regarding competences of graduates of PGR-related courses and programmes
- Develop a shared understanding of the future of PGR education in the region, regarding content, education approaches and supportive mechanisms.

Workshop programme

The 3-day workshop programme (Annex 1) consisted of:

- Session 1. Review of universities' experiences from teaching plant genetic resources courses and programmes
- Session 2. Views and feedback from PGR stakeholders: employers and students
- Session 3. Regional and international outlook regarding conservation and use of plant genetic resources, and teaching and learning approaches
- Session 4. Towards a shared understanding of the way forward
- Visit of the National Institute of Agrobiological Science (NIAS) genebank

The workshop outputs are captured in these workshop proceedings. The workshop recommendations are summarized in an Action Plan for enhancing PGR education in the region, presented on page 85.

Welcome address from the University of Tsukuba

PROF KAZUO WATANABE, UNIVERSITY OF TSUKUBA

Biodiversity has been recognized as a vital key component of sustainability in many international discussions such as the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture, the World Summit on Sustainable Development, the Millennium Ecosystem Assessment, and recent statements at COP-16 of the Framework Convention on Climate Change. Agrobiodiversity is one of the important topics within biodiversity, and it is particularly important to discuss and implement the conservation and sustainable use of agrobiodiversity for human survival in association with crop genetic resources. Plant genetic resources (PGR) is one key component of agrobiodiversity.

While there is increasing attention to the importance and specific value of PGR among global communities, it is yet crucial to facilitate the comprehension of its conservation and sustainable use in formal education and in public debate.

PGR is a basic topic of various educational and research disciplines such as botany, plant breeding, genetics, ecology, and also for industrial applications. Thus, PGR topics should always be a foundation of plant and agricultural sciences. However, there should be integration of the information that currently is scattered over different disciplines. There should also be inter-linkages of the topics nested within each discipline.

Information sharing among academic institutions should be strengthened. The delivery of the knowledge on PGR should involve various means of education, enhanced by networking and IT resources. The present meeting should help to facilitate collaboration among the participating institutions and thereby contribute towards attaining these goals.

Another important point of this meeting is the support for, and facilitation of a mutual understanding and partnership in PGR education in Southeast Asian and neighboring nations. The workshop should also explore further possibilities for a common global platform on PGR education.

With the celebration of the International Year of Biodiversity in 2010, our meeting and subsequent proceedings can raise common interest in the topic. I will serve as guidance to increase human resources on PGR issues, thereby contributing to the conservation and sustainable use of agrobiodiversity.

Opening remarks from Bioversity International

DR LEOCADIO SEBASTIAN, BIOVERSITY INTERNATIONAL

It is almost 10 years ago since the last review of PGR education in the region was done. Within those 10 years, many developments relevant to PGR have happened. Since the last meeting, the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) has now been ratified by many countries. The impact of two international assessment reports, the Millennium Ecosystem Assessment and the Intergovernmental Panel on Climate Change (IPCC) is now being felt. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) has also been presented. These reports have brought to our attention the urgency of taking actions to address the challenges of environmental degradation, biodiversity loss and climate change.

Based on these reports, we have a very strong base for giving PGR education more emphasis and priority. We expect a lot of interest and support from various sectors that wish to build capacities for the reduction of environmental degradation and biodiversity loss and adaptation to climate change.

What is happening with PGR education? In the coming days we need to review what we need to do to revitalize PGR courses and degrees and create more demand from employers and more interest among students. We all agree that agrobiodiversity, PGR in particular, is very important in our quest to cope with food security, agricultural sustainability, and climate change.

We need to turn this importance of plant genetic resources into greater demand for capacity development in this area. It is not enough that we expand the courses cover broader areas, adopt more innovative teaching approaches and create more scholarship opportunities. We also need to increase the demand for courses and degrees related to PGR. We, therefore, need to think of a broader strategy.

How can we increase the demand for graduates on PGR and raise the interest from students? Let's learn from experiences – the last meeting on PGR education in 2001 led to 13 recommendations¹:

1. Each institution will make enhanced efforts of marketing and public awareness of their own programme, and will share ideas and strategies within the network in order to increase the promotion of the programme in its region;
2. Efforts should be made to increase the scholarships and fundings available to students in order to make the programme more attractive and affordable;
3. Follow-ups and surveys of the programme graduates should be initiated by the respective universities with support from IPGRI; graduate profiles should be published in IPGRI newsletters;
4. In order to address the gaps in the current programmes, an inventory of the courses offered by the different institutions will be compiled, analyzed and recommendations will be made;
5. It was agreed to develop courses on PGR Policy and Developmental Applications of PGR to be included in the MS PGR curriculum;
6. Each institution should investigate ways to make its PGR courses available to more students and to consider offering its course as elective to students from programmes at other institutions;
7. Serious consideration should be given to the possibility of renaming the programme to make it more marketable;
8. An electronic discussion group should be created to facilitate collaboration and networking; IPGRI should be responsible for mediating this discussion group;
9. Each institution should investigate ways in which it can participate and contribute to the network;
10. The following tasks should be initiated by the network: Joint curriculum development; Student and staff exchange; Trans-boundary research; Development of publicity materials;
11. Each institution should make efforts to translate some of its existing materials into distance mode and support IPGRI's research work;

¹ Burke L, Oliver JT, Rao R, Sajise PE, eds. 2002. Collaboration in PGR education: Proceedings of the meeting on post graduate education in plant genetic resources networking. 19-21 September 2001, Serdang, Malaysia. International Plant Genetic Resources Institute, Regional Office for Asia, the Pacific and Oceania, Serdang, Malaysia.

12. Institutes planning to offer such a PGR course should consider conducting a professional market survey, as well as a technology survey in order to better assess the demand for PGR courses and the needs and capabilities of the clients;
13. A proposal for the development of a PGR policy course by distance education will be made that can then be submitted to potential donors.

Many of these recommendations have been implemented while others are still pending. Many of the recommendations are still relevant today. I am sure that some of these recommendations will re-emerge during this workshop.

Let us, however, not just make a wish list, but let us try to come up with things that will challenge us and which are also deliverable by our group collectively. Let us pursue our collective dream through collective responsibility. Let us work for results.

Global initiatives on agrobiodiversity education - A brief update²

PER RUDEBJER, LEOCADIO SEBASTIAN, BOUDY VAN SCHAGEN, MARGARITA BAENA, HENRY KAMA
BIOVERSITY INTERNATIONAL

What is agrobiodiversity and why is it important?

Agrobiodiversity—the diversity of plants and animals that underpin agricultural systems—is an important area of science and policy, yet it is rarely featured in university curricula. This brief update discusses the current global initiatives on the status of, and need to build human and institutional capacities for this subject

The Convention on Biological Diversity³ defines agrobiodiversity as all of the components of biological diversity relevant to food and agriculture, including agricultural ecosystems. It therefore encompasses the variety and variability of animals, plants and microorganisms at the genetic, species and ecosystem levels that are necessary to sustain agricultural production.

Agrobiodiversity is the result of natural selection and human intervention over millennia, and has an essential role in sustainable development:

- For providing food, fibre, fuel, fodder, medicines and other products for subsistence or sale
- For sustaining ecosystem services such as watershed functions, nutrient cycling, soil health and pollination
- For enabling species and ecosystems to continue to evolve and adapt, including adaptation to climate change
- For supplying raw genetic material for breeding new varieties of plants and animals
- For providing people with social, cultural, aesthetic and amenity values

“Agricultural biodiversity is a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystems: the variety and variability of animals, plants and microorganisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes.”

Convention on Biological Diversity

([COP decision V/5, appendix](#))

Agrobiodiversity is in rapid decline—why?

Modern agriculture is based on an increasingly small number of crops and animals. Half our energy intake from plants comes from only three species: wheat, rice and maize. In total, 90 percent of the energy and protein in our food comes from only 15 plant and 8 animal species.

Of course, new plant and animal varieties and high-input agricultural systems have dramatically increased food output. But they have also had an alarming impact on many traditional agricultural products. In Nepal, modern varieties replaced landraces on three quarters of rice cultivating land between 1960 and 2000⁴. One fifth of the world’s livestock breeds may be at risk from the intensification of farming as the global demand for meat and other animal products rises⁵.

² This paper is an adaptation of ‘Learning Agrobiodiversity: The importance of agricultural biodiversity and the role of universities’, a Brief published by Bioversity International 2009.

³ CBD 2000, <http://www.cbd.int/decision/cop/?id=7147>

⁴ FAOSTAT Database, 2006. FAO, Rome

⁵ The State of the Worlds Animal Genetic Resources for Food and Agriculture. FAO 2007. <http://www.fao.org/docrep/010/a1250e/a1250e00.htm>

Changes in land use, land degradation, deforestation and habitat loss also have severe impacts on agrobiodiversity, including the wild relatives of crops. Climate change is expected to speed the loss of agrobiodiversity as some areas become unsuitable for less tolerant varieties.

The local knowledge, which is part and parcel of agricultural biodiversity is also being rapidly lost due to migration to urban areas and changing lifestyles.

The market plays a role too, through changing food habits and globalization. Urban populations are shifting from traditional to 'modern' foods, while supermarkets demand quality, quantity, uniformity and regularity of supply that favour large scale farming.

How is the global community responding?

Ex-situ conservation efforts have been underway for some time, and about 1,700 genebanks have been established worldwide. They maintain important collections of food and fodder plants and their wild relatives, but only conserve a small part of agricultural genetic diversity. Many species are also conserved in-situ and on farms and depend on continued maintenance in farmers' fields.

Several central international policies recognize the importance of conserving and using agricultural biodiversity. The United Nations Convention to Combat Desertification (1992) states that action on desertification and drought should consider biodiversity. The Convention on Biological Diversity (CBD) was expanded to include agrobiodiversity in 1996; it is now a thematic programme under CBD. The International Treaty on Plant Genetic Resources for Food and Agriculture of 2004 secures access to seeds of the 64 most important food and fodder plants. Such commitments are now being incorporated into national policies, and capacity is urgently needed to implement them.

'Conservation-through-use'—which includes improving the market chain for minor crops—is also gaining attention. Quinoa in Peru and farro in Italy are two ancient grains now finding new popularity; traditional leafy vegetables in Kenya provide another example. Many tropical fruits are also enjoying expanding markets, as are specialty cacao and coffee, and organic and fair trade products. The move to greater diversity in agricultural products should benefit conservation while bringing income to small-scale producers and processors.

Payments for environmental services—carbon storage, biodiversity conservation, watershed functions and natural and cultural heritage – are gaining increasing attention. There are opportunities to link ecotourism development to the *in situ*/on farm conservation and use of agrobiodiversity.

How are universities responding?

To answer this question, Bioversity International recently reviewed the situation in academic institutions in Africa, Latin America and Asia-Pacific. The results indicate some common problems with mainstreaming agrobiodiversity education.

Eastern and Southern Africa

Ten universities were surveyed in Kenya, Malawi, Uganda, Zambia and Zimbabwe in 2007. None offered agrobiodiversity as a full programme at any level. However, some programmes were highly relevant to agrobiodiversity, notably the MSc in ethnobotany at Kenyatta University and the BSc in agro-ecosystems and environment at Nairobi University, both in Kenya. The survey found that most programmes related to agriculture were oriented towards a specific technical discipline, such as seed science, crop protection, horticulture, microbiology or agronomy. However, they frequently contained a plant genetic resources element, which is an important component of agrobiodiversity.

The lack of specific agrobiodiversity programmes was mirrored in the absence of dedicated courses on agrobiodiversity. Yet some aspects of agrobiodiversity were included in other courses such as ethnobotany, biodiversity conservation and traditional vegetable production.

All ten universities assessed the content of their own plant genetic resources courses as 'inadequate', and several were unhappy with current teaching approaches and methods. However, plant genetic resources and agrobiodiversity were seen as 'narrow' subjects and not likely to offer a good range of job opportunities in and of themselves.

Latin America

In 2006, surveys were conducted among 15 universities in seven countries—Chile, Colombia, Costa Rica, Bolivia, Brazil, Mexico and Peru—looking at courses and programmes in agrobiodiversity and plant genetic resources at MSc and PhD levels⁶.

As in Africa, none of the surveyed universities offered a dedicated course or programme on agrobiodiversity. However, training in plant genetic resources was available in nine MSc and seven PhD programmes from across the participating institutions, and in 11 courses at undergraduate level.

These courses were established on the basis of national or institutional priorities, not in direct response to market demand. But they mostly focused on understanding and conserving national genetic diversity, and thus seem tailored for local application.

Asia

Since 1997, Bioversity has collaborated with four leading agricultural universities in the Philippines, Sri Lanka, Malaysia and India to establish MSc programmes in plant genetic resources conservation, management and use. Additionally, Nepal's Tribhuvan University is in the process of designing a postgraduate programme on agrobiodiversity management.

Many other agricultural universities in the region offer one or two courses dealing with plant genetic resources. These specialized courses are usually taken by students majoring in plant breeding, seed technology, botany and natural sciences. There is however a general decline in enrolment in genetic resources programmes.

Bioversity's ongoing consultations with partners regarding the future of these subjects are focused on how to make courses more attractive to students, and more relevant to the job market. Some of the possible solutions are mentioned at the end of this brief.

What are the emerging gaps and challenges?

Drawing on the above lessons, and a 2009 workshop in Kenya, a global picture emerges regarding the teaching and learning of agrobiodiversity:

- Agrobiodiversity is rarely a stand-alone course or full programme. Partly this reflects a lack of career opportunities for graduates
- Many courses contain elements of agrobiodiversity, but may not cover the dynamic, multi-disciplinary dimensions of the subject
- The concept of agrobiodiversity is often not well understood among students or even educators, and there are few clear definitions

⁶ Available on-line (in Spanish) at: www.bioversityinternational.org

- There is a lack of integration of agrobiodiversity across sectors, or integration of indigenous knowledge with scientific knowledge
- Existing curriculum structures may hinder the absorption of a new discipline such as agrobiodiversity, and few subject-specific learning resources are available
- Better linkages between training, research and practice—or between conservationists and universities—would encourage take-up of the subject
- National and international policies on agrobiodiversity are still unclear⁷

After years of low priority, higher education is again on policy and donor agendas, acknowledging the fundamental role it plays in generating the innovation, skills and knowledge needed for economic growth and development. The opportunity is there for universities to adopt agrobiodiversity as another means of promoting conservation, mitigation of biodiversity loss, and sustainable use.

What are the ways forward?

The road towards the integration of agrobiodiversity into curricula may not be straightforward, and full programmes on agrobiodiversity will probably remain rare in the short to medium term. In reality, higher education curricula are often crowded and change slowly. What can then be done to strengthen existing courses without a formal curriculum review? There are several ways to raise the profile of the subject.

Initially, the integration of agrobiodiversity content into existing courses is likely to be the preferred option for most universities. Often, just a few contact hours are needed to provide at least an overview of the topic. To facilitate such integration of agrobiodiversity issues, Bioversity has identified a number of entry points for teaching agrobiodiversity (Table 1), though different options will have potential in different settings.

A second obvious option is using regular curriculum reviews. If such reviews are coming up, the curriculum committee might explore opportunities for introducing a new course on agrobiodiversity into the curriculum. Strong arguments for such introductions include:

- The importance of agrobiodiversity to farmers' livelihood and well-being
- The potential of neglected and underutilized species for securing rural livelihoods, combating poverty and improving health and nutrition
- Agrobiodiversity's contribution to climate change adaptation—genetic diversity is a precondition for breeding and evolution
- The need for capacity to implement international agreements such as the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture

A third option that some universities might consider is developing a full programme on agrobiodiversity, in particular at the post-graduate level where programmes are more flexible. As a spin-off effect, undergraduates may also benefit from the wider experience within the department.

⁷ Rudebjer P, Van Schagen B, Chakeredza S, Kamau H. editors. 2009. Learning agrobiodiversity: options for universities in Sub-Saharan Africa. Proceedings of a regional workshop, Nairobi, Kenya, 21-23 January 2009. Bioversity International, Rome, Italy.

Table 1. Entry points for introducing agrobiodiversity content in curricula.

Entry point	Example of agrobiodiversity content
Adaptation to climate change	<ul style="list-style-type: none"> • Matching crop varieties to new climates • Breeding for adaptation to climate variability , • Farmer resilience and adaptability
Agricultural economics	<ul style="list-style-type: none"> • Value chains for neglected or underutilized species • Marketing of speciality foods
Agricultural policy	<ul style="list-style-type: none"> • The International Treaty on Plant Genetic Resources for Food and Agriculture • The Global Plan of Action for the Conservation and Sustainable; Utilization of Plant Genetic Resources for Food and Agriculture • The FAO “State of the World” reports on plant, animal and forest genetic resources
Agronomy	<ul style="list-style-type: none"> • Farmers’ seed systems • The use of diversity to mitigate risk
Crop science and plant breeding	<ul style="list-style-type: none"> • Gene bank management • Participatory plant breeding • Pre-breeding • Wild relatives of crop species
Ecosystems conservation	<ul style="list-style-type: none"> • Pollination • Payment for environmental services • In-situ and on-farm conservation, eg, of cultivars or non-timber forest products
Ethnobotany	<ul style="list-style-type: none"> • Selection and management of wild plants • The cultural significance of crops and wild plants • Pharmacologically active plants
Health and nutrition	<ul style="list-style-type: none"> • Food diversity and food composition • Nutrition and traditional foods • Agrobiodiversity and traditional medicine
Soil and water management	<ul style="list-style-type: none"> • Resilience in agro-ecosystems • Microbial biodiversity

How can national, regional and international bodies support universities? There are a number of benefits from cooperation with external agencies, including:

- Increasing the participation of stakeholders in curriculum development
- Strengthening collaboration across departments and faculties to offer multi-disciplinary courses and programmes
- Encouraging networking and partnership in order to pool resources, influence decision makers, or improve access to information and materials

One such partnership for strengthening agrobiodiversity education in Sub-Saharan Africa was formed in January 2009 between Bioversity International, the African Network on Agriculture, Agroforestry and Natural Resources Education (ANAFE), the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) and the Technical Centre for Agricultural and Rural Cooperation (CTA, Netherlands). Similar opportunities can be explored in Southeast/East Asia.

In all these cases, there is a need to build awareness and develop the knowledge of teaching staff. Suitable learning materials need to be identified, adapted or developed. Contacts with international organizations and professional networks, which can be extremely valuable for identifying resources and expertise need to be established. Below, we provide some key resources and contacts that can be useful to universities aiming to address the important field of agrobiodiversity.

Links and resources

Convention on Biological Diversity (CBD) Agrobiodiversity Programme www.cbd.int/agro

Food and Agriculture Organization (FAO) Commission on Biodiversity for Food and Agriculture www.fao.org/biodiversity

Bioversity International www.bioversityinternational.org

African Network on Agriculture, Agroforestry and Natural Resources Education (ANAFE) www.anafeafrica.org

Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) www.ruforum.org

Platform for Agrobiodiversity Research (PAR) www.agrobiodiversityplatform.org

Biodiversity Planning Support Programme www.unep.org/bpsp/TS.html

**SESSION 1. REVIEW OF
UNIVERSITY EXPERIENCES
FROM TEACHING PGR
COURSES AND PROGRAMMES**

Teaching PGR - related courses: experiences from Universiti Putra Malaysia

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Introduction

Universiti Putra Malaysia was established as a university in 1971 (then Universiti Pertanian Malaysia, literally translated as University of Agriculture Malaysia). It evolved from the School of Agriculture Malaya (established in 1931) and College of Agriculture Malaya (1947). Universiti Pertanian Malaysia was renamed Universiti Putra Malaysia (UPM) in 1997 to reflect the diversity of the academic programmes it offered. Agriculture and agriculture related disciplines remain to be the focus of education at UPM, although academic programmes in other disciplines of study are also offered.

Structure and Setup

Courses Offered

UPM has been involved with teaching of PGR related courses since the establishment of the university, and has built its strength ever since. The faculties involved are the Faculty of Agriculture, Faculty of Forestry and Faculty of Science, and to some extent the Faculty of Architecture and Faculty of Environmental Studies. Courses in plant genetic resources are being offered at both the undergraduate as well as the post-graduate levels. However, there is no specific degree programme offered in PGR either at the undergraduate or post-graduate levels. The courses are being offered separately by the departments at the faculties concerned, addressing various niches in supporting the academic programmes available.

The teaching of the PGR-related courses is done in the classrooms, physical laboratories and the field laboratories (genebanks, clonal germplasm collection) and field visits. A new compulsory course, Agriculture and Man (PRT 2008) has recently been introduced, to be taken by all students enrolled in UPM, to instill upon them appreciation of the contribution of agriculture to mankind, particularly through the utilization of genetic resources. Some of the PGR-related courses offered by the faculties are shown in Table 2.

- Evaluation and assessment methods are now dominated by the application of molecular techniques, particularly on studies related to phylogenetic relationship and marker-assisted breeding, compared to the previously morphological-based classification.
- The teaching of courses is now learning outcome-based, as instructed by the Ministry of Higher Education to make teaching more objective with clear outcomes to be met.
- The curriculum has also been revised to focus on student-centered learning (SCL) approaches and include more hands-on knowledge.
- The use of computer software to assess genetic diversity is well practiced.

Table 2. Some of the PGR-related courses offered by various faculties in UPM.

Faculty	Course	Credit	Level
Agriculture <i>Programmes involved:</i> 1. Bac. Agri. Sc. 2. Bac. Hort. Sc. 3. Postgraduate	Agriculture and Man (PRT 2008)	(2+0)	Undergraduate
	Agriculture Botany (AGR 3101)	(2+1)	Undergraduate
	Field Practices: Plantation Crops (AGR 3002)	(0+1)	Undergraduate
	Field Practices: Field Crops (AGR 3001)	(0+1)	Undergraduate
	Plant Breeding (AGR 3204)	(2+1)	Undergraduate
	Industrial Crops 1: Oil Palm and Rubber (AGR 3608)	(3+0)	Undergraduate
	Agricultural Recreational Park (TKP 3301)	(2+1)	Undergraduate
	Plant Propagation and Nursery Management (HRT 3001)	(3+0)	Undergraduate
	Botany and Physiology of Horticultural Crops (HRT 3002)	(3+1)	Undergraduate
	Field Practices: Fruits (HRT 3004)	(0+1)	Undergraduate
	Field Practices: Vegetables (HRT 3005)	(0+1)	Undergraduate
	Field Practices: Ornamental Horticulture (HRT 3006)	(0+1)	Undergraduate
	Fruit Production (HRT 3201)	(2+1)	Undergraduate
	Ornamental Horticulture (HRT 3301)	(2+1)	Undergraduate
	Advanced Agriculture Botany ((AGR 4101)	(2+1)	Post-graduate
	Quantitative Genetics (AGR 4203)	(2+1)	Post-graduate
	Cytogenetics and Plant Breeding (AGR 4204)	(2+1)	Post-graduate
	Plant Micro-propagation (HRT 4701)	(2+1)	Post-graduate
Orchid Culture (HRT 4301)	(2+1)	Post-graduate	
Plantation Crops (PRT 5401)	(2+1)	Post-graduate	
Forestry <i>Programmes involved:</i> 1. Bac. Forestry. Sc. 2. Bac. Wood Technology. 3. Postgraduate	Forest Survey (FHK 3401)	(2+1)	Undergraduate
	Dendrology (FHP 3101)	(3+1)	Undergraduate
	Forest Silviculture (FHP 3105)	(3+1)	Undergraduate
	Tree Breeding (FHP 3108)	(2+1)	Undergraduate
	Forest Species Management and Eco-tourism (FHR 3613)	(2+1)	Undergraduate
Plant Dynamics (FHP 4102, and 4103)	(1+1) and (2+1)	Post-graduate, Post-graduate	
Science <i>Programmes involved:</i> 1. Bac. of (Biology Major). 2. Postgraduate	Biodiversity of Microorganisms and Plants (BGY 3101)	(3+1)	Undergraduate
	Genetics (BGY 3501)	(3+1)	Undergraduate
	Plant Chemotaxonomy (BGY 4102)	(3+1)	Post-graduate
	Biosystematics & Conservation of Seed Plants (BGY 4109)	(3+1)	Post-graduate
	Tropical Forest Ecology (BGY 4401)	(3+1)	Post-graduate
	Genetic Polymorphism (BGY 4501)	(3+1)	Post-graduate
	Population Genetics (BGY 4504)	(3+1)	Post-graduate
Quantative Genetics (BGY 4505)	(3+1)	Post-graduate	
Architecture <i>Programme involved:</i> 1. Bac. of Landscape Architecture	Landscape Plant Science (LAN 3300)	(2+1)	Undergraduate
Environmental Studies <i>Programme involved:</i> 1. Bac. of Environmental Science 2. Postgraduate (Masters and PhD)	Bio-Science for Environmental Management (EMG 3004)	(3+0)	Undergraduate
	Management of Natural Resources (EMG 4103)	(3+0)	Post-graduate
	Biodiversity and Conservation (ESC 4508)	(3+0)	Post-graduate

Teaching methods

The PGR-related courses are taught conventionally (lectures) as well as in practical classes in the physical laboratories, glasshouses and field laboratories. Assessments of genetic diversity are now often aided by molecular fingerprints, while germplasm materials are often used in breeding programmes or for multiplication purposes. Students are also required to familiarize themselves with PGR by collecting specimens for herbarium, involvements in seed and clonal multiplication, and maintenance of PGR through field practices like hybridization, bud-grafting, etc. To further increase appreciation of the subject students are taken to field visits to crop museums, greenhouses as well as plant collection centres and genebanks.

Laboratory facilities

The laboratories are now well equipped with state-of-the-art facilities for utilization and assessment of PGR, including thermal cyclers, electrophoresis equipment, gel documentation systems, sequencers and DNA extraction apparatus.

Field facilities

UPM occupies a vast area, with over 1108 ha at the main Serdang campus, and 715 ha at the Bintulu Branch Campus. Frequently referred to as the ‘green campus’, UPM is rich in plant genetic resources, maintained at the University Agriculture Park which covers 440 ha in Serdang, 163 ha in Puchong and almost 170 ha in Bintulu. The Agriculture Park harbours genetic resources of plants, animals and fish on campus, to support teaching as well as research activities. In the context of conservation of plant genetic resources, the University Agriculture Park serves as the *ex-situ* genebank for germplasm collections of numerous plant species which include cultivated tropical fruits, rare fruits, wild fruits, medicinal plants, vegetables, turf grasses, ornamental plants and forest species. These diverse crop species serve as “field laboratories” for students in PGR-related courses. Some of the main components related to maintenance and conservation of PGR include:

- Agro-genebank: mainly for cultivated, rare and wild fruits, and medicinal plants.
- Germplasm area for plantation crops: including the rubber plant clone nursery, and the oil palm, rubber and cocoa plant growing areas.
- The conservatory park: mainly for medicinal plants, ginger/turmeric, ferns, traditional vegetables, aquatic plants and wild orchids.
- Tropical fruit orchards, as sources of clonal material.
- The ornamental plants nursery: for collection and propagation of ornamental plants.
- UPM also manages 1,248 ha of forest genetic resources at the Ayer Hitam Forest Reserve which serve as “field laboratory” for students in forestry.
- Glasshouses for utilization of crop germplasm in protected environment (equipped with a fertigation system).

Trends in enrolment

In general, the trend in the enrolment of students in the academic programmes and courses related to conservation and utilization of PGR seems to be quite stable, although there is a slight decrease in the numbers. This is attributed to UPM’s policy of reducing the undergraduate enrollments as an effort to increase the intake of post-graduate students. For example, there is a slight decrease in the total number of students enrolled in compulsory courses like Plant Breeding (AGR 3204) and Biodiversity of Microorganisms and Plants (BGY 3101), but a stable number enrolled in elective courses like Quantitative Genetics (AGR 4203) and Genetic Polymorphism (BGY 4501) (see Figure 1). This indicates that students’ interest in taking PGR-related courses remained high over the years.

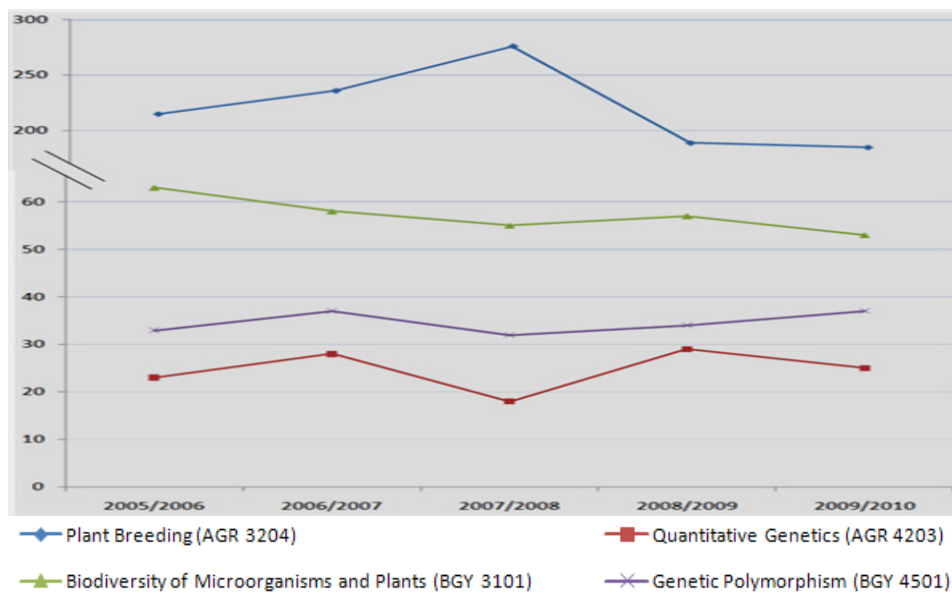


Figure 1. Trend in class enrollments for selected courses in the past 5 years.

Changes and innovations in PGR courses in the past five years

As the environment in which conservation, maintenance and utilization of genetic resources takes place changes, the development and handling of PGR-related courses also changes accordingly. Some of the changes and innovations involved are:

- Evaluation and assessment methods are now dominated by the application of molecular techniques, particularly on studies related to phylogenetic relationship and marker-assisted breeding, compared to the previously morphological-based classification.
- The teaching of courses is now learning outcome-based, as instructed by the Ministry of Higher Education to make teaching more objective with clear outcomes to be met.
- The curriculum has also been revised to focus on student-centered learning (SCL) approaches and include more hands-on knowledge.
- The use of computer software to assess genetic diversity is well practised.

Constraints and challenges

Some of the constraints and challenges that have to be overcome to ensure continued success in handling PGR-related courses include:

- The land area on campus suitable for planting of germplasm as field genebank is shrinking, to give way to buildings and other physical structures.
- Long term funding is lacking, particularly for maintenance of the field genebanks, due to lack of understanding and appreciation of the conservation of plant genetic resources.
- Teaching of PGR courses has not fully utilized information and knowledge from research findings, though research in the area of PGR has advanced rapidly, including the use of suitable protocols for collection, maintenance, etc.
- Lack of academic staff (lecturers) trained in certain areas related to PGR, particularly botanist and taxonomist, as well as support staff to assist collection, field maintenance and conservation.

PGR-related courses in the undergraduate degree programmes: University of Malaya

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Introduction

The Institute of Biological Sciences (ISB) is currently one of the institutes in the Faculty of Science, University of Malaya, which also includes: Institute of Mathematical Sciences (ISM), Department of Chemistry, Department of Physics, Department of Geology and Department of Science and Technology Studies. The IBS is the largest institute in the Faculty of Science and is the largest biology department in Malaysia. ISB has a strong workforce of 87 academic staff, 150 administrative and technical support staff with at least 2000 undergraduate and 400 postgraduate students.

IBS has a colourful history of merges and breakups dating back to the beginning of the formation of University of Malaya, Kuala Lumpur in 1959:

- 1959 – Founding of the Departments of Zoology and Botany
- 1967 – Merger of the Departments of Zoology and Botany to form the School of Biological Sciences - with 5 divisions: Botany, Zoology, Ecology, Genetics and Physiology.
- 1975 – Under the name of School of Biological Sciences, the 5 divisions merged to become three departments: Botany, Zoology and Genetics & Cellular Biology. The Physiology division was discontinued with its courses absorbed into the Zoology and Botany modules, while the Ecology division was included in the department of Zoology. In 1980, Microbiology was established under the department of Genetics & Cellular Biology.
- 1997 – The 3 departments merged to become the Institute of Biological Sciences with 8 undergraduate degree programmes.

Institute of Biological Sciences (ISB) : Programme structure

In the late 1980s to early 1990s, traditional courses were becoming less popular and there was a steady decline in student enrolment. In particular, the departments of Zoology and Botany had a record low of 6 students in the session 1987/1988. Many of the PGR-related courses were taught mainly in the department of Botany with several Ecology courses in the department of Zoology. On the contrary, the department of Genetics & Cellular Biology continued to enjoy high student enrolment and subsequent analysis showed that this pattern of student enrolment is related to the job opportunities which were then favouring graduates with a background of technology-related, non-traditional courses. Few job vacancies were available for graduates with “conventional” biology expertise.

At this point the management saw the need for a progressive educational reform, hence on June 1st 1997 the Institute of Biological Sciences was formed with 8 undergraduate degree programmes (each equivalent to a department): Ecology & Biodiversity, Science & Environment Management, Biotechnology, Biohealth Science, Biochemistry, Genetics and Molecular Biology, Microbiology and Bioinformatics and Computational Biology. These changes were crucial to meet the challenges of the 21st century and reflect current global trends in teaching and research. While keeping up with current technologies, ISB still maintains the fundamental courses (including PGR-related courses) utilizing expertise from the original departments of Zoology and Botany which are now grouped together in the Ecology & Biodiversity degree programme. It is obvious that these fundamental sciences are important because they form the base for biotechnology and other applied bio-sciences.

The new millennium has seen many calls for curriculum reviews in the biological sciences. With the advent of biotechnology, ISB formed a task force to review the curriculum taking into consideration the stakeholder's interests and needs, the nation's need for scientific advance and to address issues on food security, environment, biodiversity, and creating wealth from innovative inventions. Much thought, effort and surveys were undertaken to finally endorse the courses currently incorporated in the 8 undergraduate degree programmes.

The courses are well distributed among the 8 programmes which constitute both fundamental and applied sciences. Currently the PGR-related courses are mainly taught in the Ecology & Biodiversity degree programme (see Table 3) but there are at least 2 to 5 PGR-related courses being incorporated into various programmes (see Tables 4-6).

In the last five years, due to the emphasis on biotechnology promoted by the government, ISB degree programmes like Biotechnology, Biohealth Science, Genetics and Molecular Biology and Microbiology continue to flourish with a high student enrolment. However with the recent similar strong emphasis on agriculture and sustainable utilization of natural resources by the government, there is an interesting trend of higher enrolment to the Ecology & Biodiversity (EB) degree programme. Table 1 is an example of the course structure of this programme. The EB programme, the largest in ISB, is supported by 10 professors, 8 associate professors, 3 lecturers and 4 associate teaching staff of various disciplines with at least 11 academic staff teaching PGR-related courses.

Institute of Biological Sciences (ISB) : Facilities for teaching and research

The Institute of Biological Sciences has several facilities/stations/centres within and outside the campus, dedicated to research and teaching including PGR-related courses.

Located within the Campus are:

1. Rimba Ilmu Botanic Garden (RI)

Established in 1974, it is the first tropical Botanic Garden in Kuala Lumpur occupying an area of 80 ha. Rimba Ilmu's main mission is "to generate and promote awareness of the rich biodiversity of the tropical rain forest and the need for adequate sustained conservation through research". To achieve this, RI has developed various collections of rare and endangered plants from Malaysia, Indonesia, the Pacific Islands, Australia, South America, Africa and Madagascar. The major living collections include medicinal plants, palms and citrus plants (partly funded by the International Plant Genetic Resources Institute (IPGRI) in the 1990s), while collections of fern, ginger, rare plants, wild fruit trees, bamboo (funded by IPGRI in 2001) and bananas are still being developed. In 2000, a conservatory, housing some of Malaysia's rare plants and orchids, was established followed by a special arboretum in 2004/2005. RI also manages facilities, programmes and cooperations with local and international collaborators.

2. University Malaya Herbarium

Established in 1960, it is currently housed in the Rimba Ilmu's Administration building having more than 63,000 accessions of seed plants, 10,000 accessions of bryophytes and about 4,500 accessions of Malaysian seaweeds and seagrasses.

3. Zoological Museum

Established in 1998, it houses more than 2,400 fauna specimen except for insects and fishes.

4. Mini Farm

Occupying an area of about 1 ha, the mini farm provides facilities for animal studies, in particular on goats.

5. Transgenic Greenhouse (CEBAR)

The building was recently completed to provide facilities specifically for modern biotechnology research. This facility is managed by CEBAR, one of the research centres associated with ISB.

6. Research Centres

There are 5 research centres associated with ISB:

- Centre for Research in Biotechnology for Agriculture (CEBAR)
- Institute of Ocean & Earth Sciences (IOES)
- Centre of Research for Computational Sciences and Informatics in Biology, Bioindustry, Environment, Agriculture and Healthcare (CRSYTAL)
- Mushroom Research Centre
- Centre for Tropical Biodiversity Research

Located outside of the Campus are:

1. University Malaya Field Study Centre, Gombak, Selangor

The centre was initiated by Lord Medway of England and established in 1965. It is situated 30 km from Kuala Lumpur in a 120 ha secondary and primary forest. It provides facilities and is an ideal site for field-related undergraduate teaching and research on tropical biodiversity.

2. Jelebu Field Research Station, Negeri Sembilan

This station was initiated in 2002 and is still in the early stage of development. This centre will provide facilities for research on agriculture and conservation.

Trends in enrolment for PGR-related courses in the undergraduate degree programmes

Tables 2-4 show the PGR-related courses taught in the various degree programmes in ISB and the undergraduate student enrolment for the last 5 years. Although there was a substantial increase in students' enrolment in the academic sessions of 2006/2007 and 2007/2008, the number started to decrease in the following years. Generally, the enrolment is higher in the applied courses if compared with the fundamentals. The decreasing trend observed in the last 2 sessions might be due to the University Malaya's policy to reduce the intake of the undergraduate degree programme. Currently, much effort is focused towards increasing the intake of postgraduates. However it is also important for ISB to maintain the current numbers of undergraduates by continuously improving teaching methods and course content.

Recommendations and ways forward

University of Malaya's analysis of its PGR-related courses have resulted in a number of recommended innovations regarding both internal and external aspects.

Recommendations to improve quality of PGR education

- Website-based lecture notes
- Website-based forums, discussions and assignments
- Field studies/experience/course
- Course and teaching evaluation by students
- Site visits for selected courses including PGR-related courses

- Compulsory industrial training for undergraduate degree programmes (after the second year)
- Industry-related final year research projects
- Courses, examinations and research activities assessed and moderated by external distinguished biologists

Innovations to improve enrolment

- Improved website
- Roadshows to pre-university colleges/centres and High Schools
- Promoting biology by offering hands-on research experience in the laboratories of the University Malaya to selected excellent students
- Increase in the number of courses with field study components
- Organization of academic events at Rimba Ilmu Botanic Garden
- Programme briefings and poster exhibitions during registration

Constraints

- Funding
- University's policy in reducing the enrolment of undergraduates (due to its policy of increasing postgraduates – a requirement for a research university)
- Infrastructure and equipment
- Lack of PGR-related expertise
- Government's emphasis on biotechnology
- Job opportunities

Opportunities

- Government's recent policies on the importance of agriculture, biotechnology and biodiversity.
- Taskforce to protect biodiversity
- Government concern on sustainable utilization of natural resources
- Recent upsurge in the demand for alternative medicine and herbal products (e.g. lifestyle products)

Way Forward

- Focus on 'green science' and underexploited plant genetic resources
- Increase funding for research on food security, crop improvement, crop production
- More creative courses at undergraduate level on current issues pertaining to food security, environment and biodiversity conservation
- E-learning (distance education)

Table 3. Course structure for Ecology & Biodiversity Degree Programme.

BSc (Ecology& Biodiversity), Session 2009/2010			
University Courses (15 credits)			
Faculty Courses (6 credits)			
Core Elective Courses (83 credits)			
Compulsory Courses Programme (18 credits)			
Course Code	Course Name	Pre-requisites	Credit hour
Level 1			
SHES1200	Life Processes	<i>SPM Biology or equivalent</i>	2
SHES1201	Cell Biology	<i>SPM Biology or equivalent</i>	2
SHES1202	Biology of Organisms	<i>SPM Biology or equivalent</i>	2
SHES1203	Population Biology	<i>SPM Biology or equivalent</i>	2
SHES1270	Practical Biology	<i>SPM Biology or equivalent</i>	2
Total			10
Level 2			
	No compulsory courses		0
Level 3			
SHES3188	Ecology & Biodiversity Project	<i>Ecology & Biodiversity, Semester 5 and had completed at least 50 credit hours</i>	8
Total			8
Elective Courses Programme (65 credit hours)*			
level 2 (Choose 26 – 28 credits)			
SHES2001	Ornithology	<i>Pass SHES1202</i>	3
SHES2003	Invertebrate Biology		4
SHES2004	Human Biology	<i>Only PEB and BSc Ed students</i>	3
SHES2005	Insect Biology		3
SHES2007	Ecology of Tropical Forests		3
SHES2008	Marine Ecosystems		3
SHES2009	Limnology		3
SHES2010	Basic Mycology	<i>Pass SHES1202</i>	3
SHES2012	Genetic Processes and Evolution of Organisms		3
SHES2014	Plant Structure and Functions		3
SHES2015	Lower Plants		3
SHES2016	Higher Plants		4
SHES2017	Mammalogy	<i>Pass SHES1202</i>	3
SHES2018	Herpetology		3
SHES2019	Advanced Ecology	<i>Pass SHES1203</i>	3
SHES2020	Ichthyology		3
Total			50
LEVEL 3 (Choose 37 - 39 credits)			
SHES3003	Behavioral Ecology and Etology		3
SHES3004	Conservation Biology		2
SHES3005	Plant Reproductive Biology	<i>Pass SHES2014</i>	3

continued/ Table 3. Course structure for Ecology & Biodiversity Degree Programme.

SHES3006	Plant Population Biology	<i>Pass SHES1200, SHES1203 & SXEX1101/2/4</i>	3
SHES3007	Biology of Seagrass and Seaweeds		3
SHES3009	Economic Botany		3
SHES3011	Ecology and Management of Weeds	<i>Pass SHES1200, SHES1203 and SXEX1101/2/4</i>	3
SHES3012	Ecology and Management of Forest Insects		3
SHES3013	Ecology and Epidemiology of Parasites		3
SHES3014	Plant Systematics		3
SHES3015	Molecular Ecology		3
SHES3016	Coral Reef Ecology		3
SHES3017	Ecotourism	<i>Not offered to Level 1 students</i>	3
SHES3018	Agriculture Entomology		3
SHES3019	Applied Phycology		3
SHES3020	Applied Mycology	<i>Pass SHES2010</i>	3
SHES3021	Parasitology		3
SHES3027	Preparation, Curation and Inventory of Plants		3
SHES3031	Principles of Systematics and Systematic Entomology		3
SHES3032	Advanced Quantitative Ecology	<i>Pass SHES1203 & SXEX1101</i>	3
SHES3033	Ecophysiology of Marine Organisms		3
SHES3037	Animal Systematics		3
SHES3039	Plant Diseases	<i>Cannot be taken with SHES3359</i>	3
SHES3388	Special Topics in Ecology & Biodiversity	<i>Only for PEB students</i>	1
SHES3398	Industrial Training in Ecology & Biodiversity		3
Total			72
Programme Non-Core Courses (10 credits): Students can choose any courses from outside of the institute of Biological Sciences within the Faculty of Science.			

Table 4. Enrolment for PGR- related courses: Ecology and Biodiversity programme.

No	Course	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
1	Ecology of Tropical Forests (2)	112	111	41	32	24
2	Genetic Processes and Evolution of Organisms (2)	90	25	23	20	-
3	Plant Structure and Functions (2)	159	124	112	67	37
4	Higher Plants (2)	62	45	9	3	-
5	Advanced Ecology (2)	77	156	63	28	23
6	Conservation Biology (3)	-	27	-	63	40
7	Plant Reproductive Biology (3)	32	50	54	18	20
8	Biology of Seagrass and Seaweeds (3)	41	85	20	31	24
9	Economic Botany (3)	-	62	13	21	20
10	Ecology and Management of Weeds (3)	40	-	71	8	-
11	Plant Systematics (3)	27	56	22	11	-
12	Agriculture Entomology (3)	-	40	26	24	-
13	Applied Mycology (3)	50	45	40	17	-
14	Preparation, Curation and Inventory of Plants (3)	38	51	44	14	7
15	Plant Diseases (3)	47	73	40	26	-
16	Special Topics in Ecology & Biodiversity (3)	26	65	47	18	3

Table 5. Enrolment for PGR- related courses: Biotechnology, Biohealth Science, and Genetics & Molecular Biology programmes.

No	Course	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
1	Plant Biotechnology (2)	68	61	50	47	21
2	Tissue Culture and Cryopreservation (2)	41	103	61	39	28
3	Plant Breeding (2)	77	103	54	21	-
4	Plant Morphogenesis (3)	75	47	-	73	-
5	Genetic Engineering of Plant and Animal (3)	51	30	48	38	-
6	Ecophysiology & Plant Production (3)	23	-	-	-	-
7	Alternative Medicine (2)	71	68	71	3	5
8	Ethnobotany (2)	88	-	10	7	-

continued/ Table 5. Enrolment for PGR- related courses: Biotechnology, Biohealth Science, and Genetics & Molecular Biology programmes.

9	Taxonomy and Medicinal Plants (3)	28	8	11	1	-
10	Bioinformatics and Phylogenetics (2)	-	-	-	43	-
11	Molecular Biology of Plants (3)	19	37	38	28	-
12	Genetic Resources and Conservation (2)	9	50	36	14	-
13	Genetic Manipulation of Higher Eukaryotic Organisms (2)	-	-	-	-	-

Table 6. Enrolment for PGR- related courses: Biochemistry, Microbiology, Science & Environmental Management, Bioinformatics & Computational Biology programmes.

No	Course	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
1	Molecular Biology I (2)	-	-	58	22	-
2	Plant Biochemistry & Molecular Biology (3)	-	-	-	57	26
3	Microbial Pathogenesis (3)	39	53	47	28	-
4	Agricultural Microbiology (3)	51	60	42	24	32
5	Management of Coastal Resources (2)	-	-	-	30	-
6	Integrated Pest Management (3)	58	47	2	22	-
7	Systems and Processes in Biology (2)	52	56	51	29	22

Teaching PGR-related courses at Kasetsart University, Thailand: experiences from the past five years

HUGO VOLKAERT AND SIRIKUL WASEE
KASETSART UNIVERSITY, THAILAND

Background

The Kasetsart University was established in 1966. Currently the University hosts >16 faculties, among them agriculture, fisheries, and forestry. The Faculty of Agriculture was one of the faculties created at the University's establishment. Since 1979 the University expanded to a new campus in Kamphaengsaen, about 70 km northwest of Bangkok. More recently, other campuses were established at SakonNakhon, Chonburi (SriRacha) and, Suphanburi.

The Faculty of Agriculture at the Bangkok campus has 12 departments and the Faculty of Agriculture at Kamphaengsaen has 9 departments. The university offers BSc, MSc and PhD degrees in various agriculture and forestry related majors. An international PhD programme in Tropical Agriculture is available at the Faculty of Agriculture at both Bangkok and Kamphaengsaen.

Courses covering aspects of plant genetic resources are taught at the Department of Agronomy and the Department of Horticulture of the Faculty of Agriculture and at the Faculty of Forestry. The courses can be grouped as follows:

- Plant breeding: Several undergraduate courses in plant breeding are offered, and they generally include 1- or 2-hour lectures on 'collection, characterization, evaluation and storage of plant germplasm, including legal aspects'
- Conservation: One graduate course taught at the Faculty of Forestry (Forest Plant Genetic Resources and Management)
- Tissue culture/Molecular analysis: Various courses are offered in molecular analysis techniques, among them a laboratory course for graduate students offered by the Center for Agricultural Biotechnology.

A course exclusively dedicated to plant genetic resources is not offered at the moment. There are also no courses covering the legal aspects of germplasm management and exchange.

Trends in enrolment (statistics and analysis)

Because of the scattered organization of the teachings on plant genetic resources within different courses, it is impossible to obtain secure data on the number of students that have been trained. At the graduate level, this topic is almost completely ignored.

Changes and innovations in PGR courses in the past five years.

No changes have been made to the curriculum on PGR. However, some aspects of plant genetic resources have been discussed during non-curricular training and workshops.

For example, in May 2008, the Center for Agricultural Biotechnology at Kamphaengsaen offered an international training programme on "Plant pre-breeding". One day was devoted to a visit to the Rice Conservation Center of the Ministry of Agriculture, Department of Agricultural Research. A lecture was arranged on the contents and implications of the International Treaty on Plant Genetic Resources for Food and Agriculture.

Constraints and challenges

In spite of the hype surrounding plant genetic resources and their conservation, there is not a single course specifically designed to cover the matter, and students who would be interested in this subject need to gather information from various sources. This does not mean that expertise on plant genetic resources is missing in Thailand. Various people have been trained in related programmes abroad.

Opportunities (policy, resources)

Unfortunately, Kasetsart University at this moment cannot offer much in respect of plant genetic resources education. Research on plant genetic resources is being done by individual laboratories at the university, especially focusing on molecular characterization of genetic diversity in crop plants. One good example where plant genetic resources are studied intensively is the Tropical Vegetable Research Center. The necessary human resources and expertise are present at the university and thus it would not be difficult to actually bring these people together and offer a course focusing on PGR.

Moving forward

It would be beneficial to the country if a course on plant genetic resources would be initiated covering aspects of exploration, conservation and characterization of crop germplasm resources and the legal framework for patenting and exchanging germplasm.

The university will offer an International Programme in Agricultural Biotechnology in the near future, and it is anticipated that PGR management and utilization will become part of the curriculum.

Vegetable germplasm management at Kasetsart University

SIRIKUL WASEE

TROPICAL VEGETABLE RESEARCH CENTER, KASETSART UNIVERSITY, THAILAND.

Introduction

Tropical Vegetable Research Center (TVRC), Kasetsart University, Kamphaeng Saen was established in 1988 aimed at working on germplasm management, varietal development and production technology of both cultivated and indigenous vegetables. The Center currently maintains more than 12,000 accessions of diverse vegetables in its germplasm unit. The collection contains about 34 vegetable crops conserved as seeds or as active, “living” collections and more than 100 indigenous vegetable crops maintained in a field plot.

The vegetable germplasm conserved at TVRC is obtained from international institutions and local collections. The material is complemented with collecting information, passport data, characterization and evaluation data and seed distribution information. Characterization is done during the first regeneration cycle. The descriptions of the characteristics follow the descriptor list of the former International Board for Plant Genetic Resources (IBPGR) and the International Plant Genetic Resources Institute (IPGRI). The collecting information and characterization data are recorded in a “passport” and in computerized databases.

To enhance utilization of the collections, evaluation of desirable traits of a particular crop such as yield, agronomic and horticultural traits and resistance to diseases and insects have been done by a multidisciplinary team of scientists.

Vegetable germplasm for seed production and preservation at TVRC is grown under preferable conditions for production of good quality seed and high seed yield. Isolation and pollination procedures are necessary to prevent cross pollination or to preserve the genetic constitution of the accession. At TVRC, net cages are used to grow each accession (see pictures below).



Net cages for producing good quality seed and preserving genetic constitution of the accession.

The amount of produced seeds should be high enough to cover the need for active and working collections. At TVRC the established practice is to produce 4000 seeds/accession which are kept in medium term storage and some seeds for research and distribution. After harvest at the physiological maturity stage the seeds are recovered and cleaned. The protocol for recovery and cleaning depends on the particular crop. Decreasing seed moisture content to 5-8 % is necessary for longevity of the seeds in storage. The seeds are sun-dried and stored in a dry-room before packing. They are packed in aluminium foil with the label of accession number, date of packing, germination test and other related information on the cover as well as inside the pack (Figure 2) to prevent misidentification of the accessions. For medium term storage the germplasm seeds are kept at about 10-15 °C with 50% relative humidity.



Seeds are packed in aluminium foil with information on the cover as well as inside the pack to prevent misidentification of the accessions.

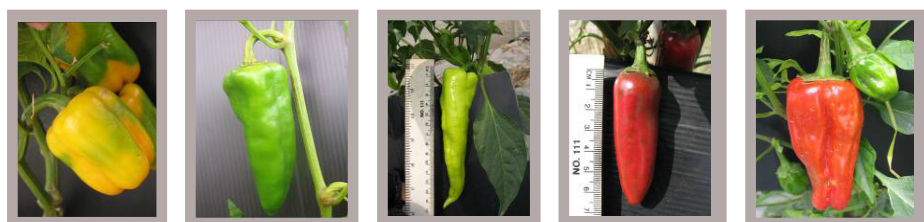
TVRC is currently distributing seeds for further research in the country, subject to the terms and conditions described in the Material Transfer Agreement (MTA). The processing and mailing fee for each germplasm accession (50 seeds) is 100 Baht (about US\$ 3). The requested seeds will be dispatched to the recipient after the Center received the signed MTA and the payment. Information about the performance of the requested germplasm is returned to the Center and added to the database.

Exchange of germplasm for further breeding and research is a bilateral agreement between the two parties. Procedures will follow a signed Memorandum of Understanding (MOU).

Evaluation of horticultural qualities

Over the past 3 years, TVRC has gained experience in the management of pepper germplasm. The project, funded by the National Science and Technology Development Agency (NSTDA), had as objectives to evaluate good horticultural qualities and resistance to diseases and insects. The project was conducted on 630 pepper germplasm accessions with seeds originally acquired from the Germplasm Resources Information Network (GRIN) and local collections. The project was a collaboration of TVRC, Department of Horticulture, Department of Pathology and Department of Entomology, Kasetsart University, Kamphaeng Saen, Nakhon Pathom.

Types of pepper were classified into 3 categories based on fruit size and utilization. Large fruits consist of bell, ancho, cayenne, long green/red and sweet pepper. Small fruits include hot chili and Tabasco. Ornamental pepper which varies more in fruit size and shape is the third group.



Group 1. Large Fruits.



Group 2. Small Fruits.



Group 3. Ornamental Pepper Group.

Anthracnose resistance

Pepper germplasm was examined for anthracnose (*Colletotrichum capsici*) resistance in a greenhouse by inoculation with spore suspension. Disease incidence analysis was done by categorizing plants into different resistance groups: susceptible (S), moderately susceptible (MS), moderately resistant (MR) and resistant (R). Seventeen accessions with a resistance level varying from 0-18% disease incidence were found. They were designated CA752, CA822, CA892, CA911, CA924, CA927, CA1110, CA1131, CA1180, CA1181, CA1186, CA1245, CA1251, CA1299, CA1302, CA1394 and CA1429.



Fruit inoculation with spore suspension followed by covering with plastic bags for 2 days.



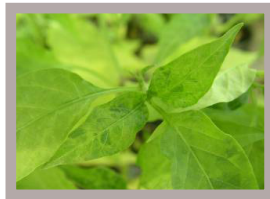
Anthracnose symptom on pepper Resistant accessions.

Virus resistance

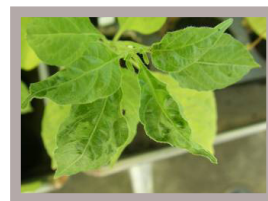
Screening for Cucumber Mosaic Virus (CMV) and Chili Veinal Mottle Virus (CVMV) resistance of pepper germplasm was done under greenhouse condition. The mechanical inoculation technique was applied to pepper seedlings at the 3-5 leaf stage. Visual observation of symptoms on inoculated plants and the indirect Enzyme-linked Immunosorbent Assay (indirect ELISA) were used for determination of the virus concentration and thereby for resistance evaluation 2 and 4 weeks after inoculation. Variety CA1304 was immune (0% infection) to CMV and varieties CA446, CA860, CA1131, CA1195, CA1258 and CA1338 were immune to CVMV.



Inoculation technique



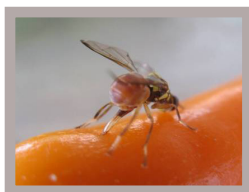
CMV symptoms



CVMV symptoms

Fruit fly resistance

Pepper germplasm was evaluated for resistance to the Malaysian fruit fly under 20 fine mesh coverings. Fourty pairs of 14-21 day-old Malaysian fruit flies were released underneath the coverings for evaluation of pepper resistance. Resistance was categorized into highly resistant (HR; 0 %YLF), resistant (R; 1-25 %YLF), moderately resistant (MR; 16-50 %YLF), moderately susceptible (MS; 51-75 %YLF) and susceptible (S; 75-100 %YLF) based on the yield loss caused by fruit fly. Varieties CA1131, CA1187, CA1373, CA1394, CA1429, CA1634, CA1657-A, CA1747-A, CA1632 and CA1828 are the resistant accessions.



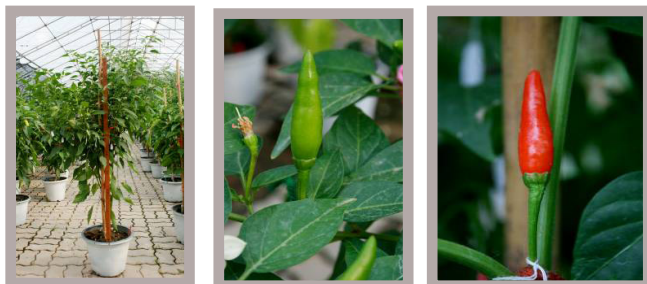
Oviposition of fruit fly on fruit skin



Yield loss caused by fruit fly infestation

Disease and insect resistant accession

CA1131 is the only accession among the 630 tested that showed resistance to anthracnose, CMV, CVMV and fruit fly infestation (see picture below).



Acknowledgments

I wish to acknowledge with deep appreciation my collaborators Mr. Krung Sitadhani, Dr. Julapark Chunwongse, Dr. Ratiya Pongpisutta Dr. Sujin Patarapuwadol and Dr. Pramote Saridnirun. In particular, I am grateful to Dr. Pongthep Akaratanakul and Dr. Wichai Kositratana for giving me an opportunity to present this paper. I also wish to express my thanks to National Science and Technology Development Agency (NSTDA) for the financial support to the project 'Pepper Germplasm Management'.

Teaching of PGR related courses – the University of Nottingham experience

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SCHOOL OF BIOSCIENCES, UNIVERSITY OF NOTTINGHAM MALAYSIA

Structure and setup

The University of Nottingham has an international reputation for excellence in teaching and research in the areas of plant and crop science related to agriculture and horticulture. In the UK, these activities are now mainly centred in the School of Biosciences at the Sutton Bonington Campus, formerly known as the 'School of Agriculture'. Prior to integration in the School of Biosciences, plant genetic resources related teaching and research were also carried out in the former Department of Botany at the University Park Campus. Plant studies are now also carried out in the School of Biosciences at a branch campus in Malaysia.

The University of Nottingham is home to >35,000 students, of which 6,000 are international from >150 nations. It is truly a global institution with campuses in the UK, one in Malaysia (Semenyih, near Kuala Lumpur) since 1999 and one in China (Ningbo) since 2004. The first campus was established at Nottingham in 1798.

The University is research-led as was clearly shown by the outcome of the latest UK Research Assessment Exercise (RAE) 2008. In the 2008 RAE, Nottingham holds first positions in the areas of Agriculture, Veterinary and Food Science.

Trends in enrolment

Over the past five years, there has been a continuing downward trend in student enrolment for agriculture and horticulture courses, especially at the undergraduate level. This has also occurred at Nottingham, however taught and research postgraduate programmes in plant and crop science have continued to be supported, especially by international students.

Changes and innovations in PGR courses in the past five to ten years

At the School of Biosciences (Sutton Bonington Campus, UK), undergraduate and postgraduate courses have focused on plant and crop physiology, physiological assessment and genetic assessments of biodiversity, use of molecular markers to determine genetic relationships (e.g. to understand populations and conserved genes across species) and bioinformatics (especially through the activities of the Nottingham Arabidopsis Stock Centre (NASC)).

In the School of Biology at University Park, Nottingham, courses on biological imaging and photography have been developed over a number of years and now provide opportunities for detailed documentation of plant genetic resources in conjunction with field studies.

A major development in the School of Biosciences relevant to plant genetic resources has been the setting up of teaching programmes in plant & crop biotechnology at the Malaysia Campus (UNMC). UNMC is a fully integrated campus of the University of Nottingham and offers degree programmes identical to those at Nottingham in the UK. Senior staff is seconded from the University of Nottingham in the UK. Quality Assurance and assessment procedures for both teaching and research are controlled from the UK, and the teaching programmes have also been accredited by the Malaysian Qualifications Agency.

The University was invited to open a Branch campus by the Malaysian Government in 1998. Initially the campus comprised an office building located in the centre of Kuala Lumpur. The first student intake was in September 2000. In September 2005, a purpose built campus at Semenyih was officially opened and now accommodates approximately 3,600 students across four Faculties: Engineering, Science, Social Science and Arts & Education. Biosciences is one of four Schools in the Faculty of Science, namely Biosciences, Pharmacy, Computer Science and Psychology.

Currently the programmes offered in the School of Biosciences at UNMC focus on biotechnology applied to plants/crops and include a Foundation Programme in Biosciences (3 semesters), a BSc (Honours) Plant Biotechnology (3 years), an MSc Crop Biotechnology (1 year taught Masters with research project), MPhil (2 years by research) and PhD (3 years).

The aims of the BSc and MSc programmes are (i) to provide graduates with an advanced knowledge and comprehensive understanding of the theoretical, practical and transferable skills of plant/crop biotechnology and related biotechnologies and (ii) to widen graduate awareness of the latest developments of agro-industry in the area of plant/crop biotechnology.

In the BSc in Plant Biotechnology, students in year 1 study biological and other sciences and acquire laboratory skills for experimentation and research. In years 2 & 3, they study the theory and attain practical transferable skills in plant genetic improvement and technologies relevant to plant biotechnology, crop science, plant breeding and genome research. A research project is planned in semester 4 and carried out in semesters 5 and 6. This project is very important in terms of learning outcomes and constitutes one third of a student's assessment in the final year.

The MSc in Crop Biotechnology is an intensive one year programme in which students integrate theory and practice from molecular/biochemical levels to the physiological analysis of whole organisms and performance of plant communities. Taught modules include the following:

- Principles of Crop Science
- Crop Research Techniques
- Fundamental & Applied Aspects of Plant Genetic Manipulation
- Plant Genetic Manipulation: Practical Techniques
- Genetic Improvement of Crop Plants
- Experimentation & Computing
- Sexual & Somatic Genetics for Plant Improvement
- Current Issues in Crop Biotechnology
- Crop Protection: New Perspectives
- Tropical Crops

A research project is planned and completed within this year and constitutes approximately 45% of a student's assessment for the MSc.

Students registered for MPhil and PhD undertake research to investigate a selected field in the area of plant/crop biotechnology.

In the School of Biosciences in the UK and at UNMC, core strengths are not in biodiversity *per se* but in practical applications including agricultural biodiversity, agroecology and pharmaceuticals from plants. Many of the modules taught in the BSc and MSc programmes contain topics directly related to plant genetic diversity, for example, seed development, physiology and storage and germplasm conservation *ex situ* and *in situ*. One module in the BSc programme entitled 'World Agroecosystems' contains sessions on agrobiodiversity and conservation of plant genetic resources.

Some of the strengths of the teaching and research in plant/crop areas can be attributed to the cooperation between academic staff in the UK and staff at UNMC. Likewise the links between staff in Biosciences and in Pharmacy also provide strengths in terms of the chemistry of plants that contain novel compounds of potential value as pharmaceutical, nutraceuticals etc. In addition there is mobility of staff and students between Campuses. UK staff visit UNMC to provide some inputs to teaching and to discuss cooperative research. Likewise UNMC staff visit the UK campuses to discuss developments in teaching and research. Undergraduate students in the second year of their course (at both UNMC and Sutton Bonington campuses) have the opportunity to spend one or both semesters at the other Campus. This is possible because the modules taught are the same on both campuses.

A further strength is the recently opened AAR-UNMC Biotechnology Research Centre which is a joint venture between the plantation crops company Applied Agricultural Resources (AAR) and the University of Nottingham Malaysia Campus. This Research Centre, which is located next to the Malaysia Campus in Semenyih, was set up in 2008 with the brief to expedite oil palm genetic improvement through modern biotechnological approaches capitalizing on UNMC expertise in this field. The remit is not restricted to oil palm and the School of Biosciences is focusing on a range of crops, including several underutilized species. The Research Centre contains excellent facilities for teaching and research in the areas of plant tissue culture and molecular biology.

Current research activities in the School of Biosciences at UNMC relevant to plant genetic resources include:

- Molecular markers as a means of increasing the efficiency and effectiveness of genetic improvement programmes in tropical crops. Studies involve marker assisted selection, determination of genetic fidelity during tissue culture, fingerprinting and genotyping.
- Underutilised crops – includes biology, genetic diversity, agronomy and utilization.
- Plant disease control through understanding of pathogen biology, pathogenesis and molecular interactions between host, pathogen and potential biological control agents. Includes natural products as alternatives to fungicides, coatings to enhance shelf life etc.
- Plant tissue culture for the cloning of selected local plants either for conservation or for mass production
- Post-harvest technology for extending the post-harvest life of tropical fruits and vegetables and for the 'harvest' of novel compounds for drug formulation.

Constraints and challenges

The main constraint on developing a course dedicated to plant genetic resources is the limited number of students applying for such a course, which may be related to the limited career openings for such specialised graduates. This would suggest the need to promote teaching of plant genetic resources within existing Diploma and Degree programmes and to consider specialist courses at the Masters level.

Opportunities

Using research in teaching

The School of Biosciences has adopted a project-based hands-on approach to teaching molecular skills relevant to plant genetic resources in a module entitled 'Genetic Improvement of Crop Plants' taught to level 3 undergraduates and to MSc students. Groups of four students work with a mentor to design laboratory work to address a specific issue in crop population genetics and diversity using molecular markers.

Past examples include:

- Assessing the purity of tea through genetic analysis of made tea fragments from supermarket shelves. The specific issue of interest is the adulteration of Darjeeling teas.
- Investigating the origins of avocados using DNA extracted from embryos of supermarket samples compared to reference origins. Here the issues are where does our food come from and is what it says on the box true?
- Investigating the population structure within landraces of the bambara groundnut (*V. subterranea*), a drought tolerant African legume used in subsistence farming. What are the implications of genetically heterogeneous crops rather than varieties and how do we assess them?

The students propose detailed experimental methods (within a limited cost budget) to attempt to address the chosen question. This is assessed and returned. They then carry out the practical work that they have proposed in lab-based sessions, supervised by their mentor. They analyse the resulting data, identify problems and possible solutions and determine whether the question was answered. The projects are written up and presented orally to the rest of the class.

This approach simulates the entire process of experimental design, costing, grant application and experimental execution and evaluation which would occur in a genuine research grant. By working closely with a mentor who is experienced in this research area students are able to experience how 'real' research works. Students also learn that seemingly 'simple' questions are often more complex to answer in practice.

Exploitation of recently developed molecular techniques to characterise plant genetic resources

The Diversity Arrays Technology (DArT), www.diversityarrays.com is a slide based microarray technique for fingerprinting. Because the technique works through a hybridization step (much as Restriction Fragment Length Polymorphism; RFLPs) it is locus-specific, so a fragment detected in one sample which is also detected in an unrelated sample is almost certainly the same fragment. The locus-specificity allows datasets to be compared and to be compatible. There is a no requirement for extensive sequence data to be available for the technique to be applied to a crop, which means DArT could be developed for any crop.

As an example, Nottingham has investigated the relationships between bambara groundnut accessions from the International Institute of Tropical Agriculture's (IITA) germplasm bank, with 557 accessions of approximately 2000 held being analysed. From this analysis, UPGMA dendrograms comparing genetic relatedness have been prepared using 296 unique and informative DArT markers. The different groups discovered have been mapped back onto the geographical origins given by the IITA accession data. This reveals four main groupings with a clear division between East and Central Africa and material from Southern Africa. Understanding the genetic relatedness of the available plant genetic resources in germplasm collections is a key step to breeding crops for future environments.

Reducing the cost of genetic analysis to investigate plant diversity

The cost of producing the sequence needed to create microsatellites (the DNA marker of choice for investigating plant genetic resources due to reliability and co-dominance) can be reduced significantly by using 454 Pyrosequencing (www.454.com). A typical cost in the UK for Sanger sequencing 1000 clones from a single library would be £5,000 however this can be reduced 25-fold using the 454 approach. The cost then becomes low enough to allow initial genetic markers to be made for any species. As a proof of principle we generated 8 microsatellite-enriched libraries for different species and used a 1/16'h 454 Pyrosequencing run to generate enough sequence to begin developing microsatellite markers for these species.

The sequence for each library costs an average of £250. The markers that are then developed can be used to investigate the breeding system, population structure and genetic diversity of a species. So far, 40 functional microsatellites have been developed from the date palm library and markers are being developed for *Lablab purpureus*, Maya nut (*Brosimum alicastrum*) and *Gomortega keule*.

Using resources from major crop species to investigate other plant species for expression or genetic diversity

High density microarrays are extremely powerful ways to investigate both genome and transcriptome, but require very large sequence databases for that species to be developed. The XSpecies (<http://affymetrix.arabidopsis.info/xspecies>) approach uses non-homologous microarray chips to produce a 'virtual' chip for a new species. For plant species, this has been achieved on *Arabidopsis* for *Brassica* (various), tomato, potato, lettuce, tea, bambara, periwinkle and oil palm, and on rice for banana and others.

Studies of underutilised plant species

The University of Nottingham Malaysia Campus is the joint co-host with the Bioversity International Asia, Pacific & Oceania office in Serdang, Malaysia, for a new international organization "Crops for the Future (CFF)". It has a global mandate for underutilised crops. This organization will provide a coordinated effort to the evaluation of underutilised plants for food and non-food uses. In addition to their potential value for health, nutrition, pharmaceuticals, energy and materials, consideration will be given to marketing and market access and their ability to adapt to climate change.

This is an exciting opportunity for institutions to network globally to harness the potential of underutilised plants and to contribute to more sustainable forms of agriculture for future generations. Plant genetic resources are a key component of this development and an understanding of a species breeding system, genetic diversity and population structure will be important to identify the most promising candidates for investigation. Initially there will be prioritization in terms of species and disciplines, after which a knowledge based approach will be established, both for indigenous and scientific information. Innovative research and development methodologies will be required to maximise the potential of these underutilised plants with capacity-building for end-users.

Moving forward

Teaching of plant genetic resources at the University of Nottingham will continue to be linked with research activities in the areas of biotechnology as applied to plant propagation and conservation, molecular biology in terms of molecular markers and germplasm characterization and bioinformatics. The characterization of germplasm should be improved with the use of next generation sequencing, as it should be possible to develop robust, species specific markers for almost any species at reasonable cost.

While much research at Nottingham University (including future CFF research) starts from the agronomy end, it is considered important to integrate the targeted use of markers for quality control from the outset and to elucidate fundamental traits, such as breeding system and inheritance. Teaching of plant genetic resources will continue to be an integral part of plant studies at undergraduate and postgraduate levels, however it is difficult to justify the establishment of a dedicated degree.

To facilitate the appropriate education and training of students for careers in plant genetic resources, a network of centres in the Asian region should be set up to provide the theory, laboratory skills and field skills for a robust professional qualification.

SESSION 1

Teaching PGR-related courses: experiences from Kangwon National University, Korea

NAM-SOO KIM, DEPARTMENT OF MOLECULAR BIOSCIENCES, KANGWON NATIONAL UNIVERSITY
JU KYONG LEE, DEPARTMENT OF APPLIED PLANT SCIENCES, KANGWON NATIONAL UNIVERSITY

Structure and setup

Kangwon National University (KNU) is one of the leading national universities in Korea. It is located in Chuncheon, the capital city of Gangweon Province, Korea, 95 km north east of Seoul, in the coldest province of the country. KNU has a total enrolment of 15,000 undergraduates and 3,000 graduate students, respectively.

The Department of Applied Plant Science in the School of Agriculture and Life Sciences as well as the Department of Plant Biotechnology in the School of Biosciences and Biotechnology are both involved in various aspects of plant genetic resources (PGR). The 10 acres of land of the university farm, located 15 km away from KNU's main campus are allocated for the propagation and maintenance of plant genetic resources. PGR maintenance and preservation programs at the KNU are currently supported by two National Institutes: Rural Development and Administration (RDA) and the Korea Science and Engineering Foundation (KOSEF) (this institute recently merged with Korea Research Foundation and has been renamed as the National Research Foundation of Korea). We have several *in situ* preservation programs for PGR that are supported by either of these institutes, including on *Perrilla*, lilies, foxtail millet, sorghum, millet, and potato. The seeds or clones of the germplasm resources were either directly collected by the programme leaders or obtained from the Germplasm Centre in RDA. More details on the project are elaborated below.

Trends in enrolment (statistics and analysis)

PGR has been offered as an undergraduate course by the Department of Plant Biotechnology since 1990. Since this is a third year course, students are required to have taken prerequisite courses in plant genetics, molecular biology, seed science, and plant breeding. Enrolment in the course is usually between 20 to 30 students, and varies each year, depending on the number of registered students in the Department.

A similar course is offered in the Department of Plant Sciences in the fourth year in which the enrolment has also been between 20 to 30 students each year.

Two PGR courses are offered at the graduate level: The Department of Plant Biotechnology offers Advanced Plant Resources while the Department of Plant Sciences offers Topics of Advanced Plant Resources. However, these courses are not offered every year; instead they are offered every two or three years, depending on the demands of the students.

Changes and innovations in PGR courses in the past five years

Textbook development

We developed a textbook in 2004, entitled, "Introduction to Plant Genetic Resources", which was co-authored by 12 individuals who are specialists in their fields of study. The textbook has been used for the Plant Genetic Resources undergraduate course in the Department of Plant Biotechnology. We are currently preparing a revised version of the book that will contain 14 chapters, the titles of which are described in the syllabus for the course shown below.

BOX 2. AN EXAMPLE OF THE SYLLABUS OF A PLANT GENETIC RESOURCES COURSE.**NAME OF THE COURSE:** PLANT GENETIC RESOURCES**INSTRUCTOR:** DR. CHEOL-HO PARK, DEPARTMENT OF PLANT BIOTECHNOLOGY**ROOM:** AGRICULTURE BUILDING 1; RM. 216**LECTURE TIMES:** MONDAYS AND WEDNESDAYS FROM 9:00AM – 10:15AM**TEXT:** “INTRODUCTION TO PLANT GENETIC RESOURCES”**LECTURE**

1. DEFINITION OF PLANT GENETIC RESOURCES
2. IMPORTANCE OF PLANT GENETIC RESOURCES
3. EXPEDITION AND COLLECTION
4. EVALUATION AND USAGE
5. STRATEGIES FOR LONG-TERM STORAGE
6. SEED QUALITY CONTROL
7. BIOTECHNOLOGY FOR PRESERVATION AND UTILIZATION

MIDTERM EXAM

8. MOLECULAR GENETIC EVALUATION
9. INFORMATICS FOR PLANT GENETIC RESOURCES
10. CONTRIBUTIONS OF PLANT GENETIC RESOURCES FOR CULTIVAR DEVELOPMENT
11. INTERNATIONAL COLLABORATION
12. STATUS OF PLANT GENETIC RESOURCES WORLDWIDE
13. MANAGEMENT OF PLANT GENETIC RESOURCES AND INTELLECTUAL PROPERTY RIGHT
14. PLANT GENETIC RESOURCES AND INDUSTRY

FINAL EXAMCollaboration

The Germplasm Institute of RDA holds about 500,000 accessions of diverse plant species. Characterization, maintenance, and seed replenishment of these accessions are very labour intensive tasks. Thus, collaboration programmes have been developed between the Germplasm Institute and the Korean universities. As a result 29 projects are currently operating in Korea. KNU is involved in the preservation of *Perrilla*, lilies, foxtail millet, sorghum, and millet accessions.

The Germplasm Institute of RDA provides funding for the projects. In return, the participating universities are responsible for the maintenance, replenishment, and characterization of the allocated bioresources. Certain portions of the replenished seeds are deposited with the Germplasm Institute each year, for long-term preservation. In the mean time, the “passport” field data are shared by both bodies. These programmes are of mutual benefit to both the university scientists and the germplasm institute. The major benefit for the university scientists is secure, long term funding for plant genetic resources programs, which facilitates the training of graduate students in this topic. The benefit for the institute is the replenishment of the seeds and characterization of the germplasm by the university scientists.

The lily programme at the KNU is an excellent example of a collaborative programme between the Germplasm Institute of RDA and a Korean University. Since 2000, Professor Jong-Hwa Kim of the KNU's Department of Horticulture has collected over 813 accessions of *Lillium tigrinum*, *L. brownii*, and *L. leichtinii* var. *tigrinum* from Korea. His collaboration with RDA started in 2007, and is expected to continue until 2011. Each year, 100 accessions are characterized for horticultural characteristics and deposited with the Germplasm Institute for long-term storage. The Germplasm Institute has provided him with funds for the collection and maintenance of his accessions as well as for supporting graduate students involved in the project.

The schematic representation below outlines the collaborative programme between KNU and Germplasm Institute of RDA for the conservation of *Lillium* species.

Another example of a collaboration project is the collection and preservation of the *Perrila*, foxtail millet, sorghum, and millet accessions, which is conducted by one of the coauthors of these proceedings, Professor Ju-Kyong Lee. He collected 448 accessions of *Perilla frutescence* var. *frutescens*, 138 accessions of *P. frutescens* var. *crispa*, 137 accessions of *Sorghum vulgare*, 93 accessions of *Setaria italic*, and 24 accessions of *Panicum milaceum* from Korea. All of these accessions were duplicated, and are currently being preserved by both the university and the Germplasm Institute of RDA. The field "passport" data are being shared by both parties for future utilization. This programme was initiated in 2006 and will end in 2010.

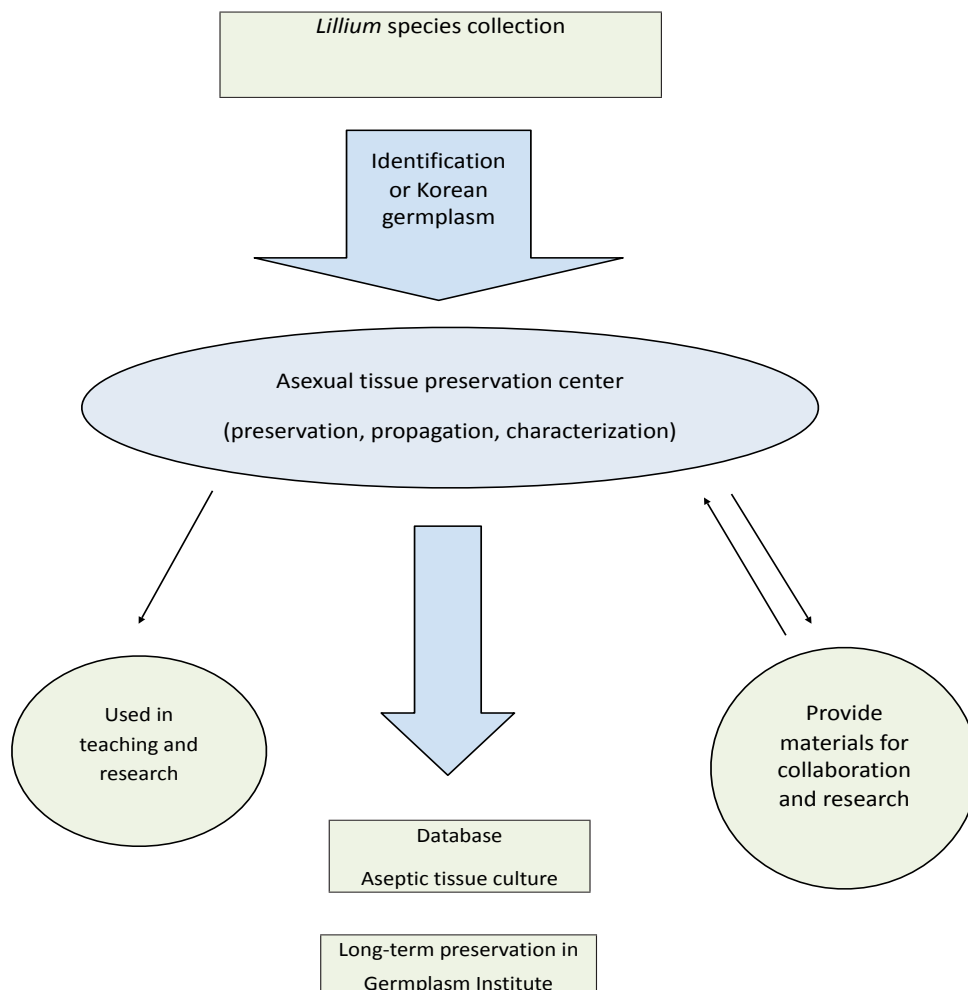


Figure 2. The lily (*Lillium*) programme at Korea National University.

Enrolment

In 2009, the Department of Plant Sciences and the Department Plant Biotechnology have current enrolments of 123 and 105 undergraduates, respectively. The same departments have current enrolments of 15 and 20 graduate students, respectively. Of the graduate students, 4 in the Department of Plant Science are PGR major students while none of the graduate students in the Department of Plant Biotechnology are PGR majors.

Constraints and challenges

Teaching a PGR course is fraught with many challenges. The most significant is the lack of public interest in agriculture. The number of graduate students in PGR laboratories has been dwindling. As depicted above in the enrolment of graduate students, the top or competent students usually select a PGR major as their second or third choices. The major deterrents in attracting students are the paucity of PGR related jobs in the public sector and the reluctance of the industrial sector to advertise vacant positions in PGR.

Teaching quality courses and training in PGR comprises field expeditions, laboratory experiments, and classroom teaching. A constraint on quality teaching has been the lack of funding for PGR courses; the size of the grant is not sufficient for the inclusion of field trips and laboratory work in these courses.

Opportunities (policy, resources)

KNU is located in the Gangweon province, the northernmost and most mountainous terrain in Korea. Most of the region is rural in nature so that numerous landraces of upland crops are still cultivated by the farmers. Thus, it is our responsibility to collect and establish core collections of these resources. Farmers are being made more aware of the importance of the *in situ* preservation of these PGRs. We are currently developing programs to preserve these landraces, e.g. payment of financial subsidies.

Moving forward

Rapid urbanization has rendered many endemic species endangered by elimination; thus, the importance of and the need for PGRs cannot be overemphasized. More and more regulations are being implemented to control PGRs. Each year, many accessions are being introduced into the Germplasm Institute without adequate characterization. It is imperative that these accessions will be checked for genetic redundancy. There are many molecular techniques that can be employed to do so. At KNU, our graduate students are not only trained in the use of the conventional methods for evaluating PGRs but also in the use of current molecular techniques and bioinformatics. Students equipped with an understanding of genetics, molecular biology, and familiar with the tools in bioinformatics will venture into the preservation, handling, and utilization of PGRs.

Plant genetic resources education in the Pacific

TEVITA KETE AND THE GENETIC RESOURCES TEAM

LAND RESOURCES DIVISION, SECRETARIAT OF THE PACIFIC COMMUNITY

Introduction

The paper highlights the status of plant genetic resources (PGR) education in the South Pacific. The Secretariat of the Pacific Community with the assistance of Bioversity International is instrumental for promoting PGR in the region. This also covers training, whether it is short, medium or long term.

Secretariat of the Pacific Community (SPC) and the Role of Agriculture and Forestry in the Region

SPC is an international organization that provides technical assistance, policy advice, training and research services to 22 Pacific Island countries and territories in areas such as health, human development, agriculture, forestry and fishery. All of these areas are crucial for the people of the Pacific, who continue to face challenges from their remote locations and scarce resources, as well as new challenges from growing populations, decreasing food security and the effects of climate change. SPC has served the people of the Pacific for more than six decades – and it celebrated its 60th anniversary in 2007. In that time, it has grown to become the largest developmental organization in the Pacific with around 350 staff and offices in Noumea, New Caledonia; Suva, Fiji Islands and Pohnpei, Federated States of Micronesia.

Pacific Island countries and territories (PICTs) are geographically, ecologically, sociologically and economically diverse. The region is home to an estimated 9.5 million people on islands with a land area of 550,000 km² surrounded by the largest ocean in the world. Five of SPC's 22 member PICTs (Fiji Islands, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu) account for 90% of this total land area and more than 85% of the population. The region is also home to some of the world's smallest island states and territories, such as Nauru, Tuvalu and Tokelau. The importance of the agriculture and forestry sector in sustaining livelihoods varies greatly.

These sectors remain the mainstay of the economy and employment in Papua New Guinea, Solomon Islands and Vanuatu and contribute significantly to household income and increasingly, export earnings. In contrast, in some of the smaller PICTs, agriculture is mainly based on subsistence farming and activities in the forest sector and involves management of watersheds and coastal forests, and agroforestry development. PICTs face numerous social and physical challenges in maintaining and improving the productivity of their agriculture and forestry sectors and protecting their biological diversity.

Plant Genetic Resources Development in the Region

In the early 1990's disaster struck Samoa in the form of taro leaf blight, which virtually destroyed all taro production in Samoa. At the time Samoa had a vibrant taro export market worth US\$3.5mn. Unfortunately that market had been based on one variety which was totally susceptible to the disease, as were the other local Samoan taro varieties. The huge impact of this disease highlighted the importance of crop diversity, that is, the cultivation of different species and varieties, both for export markets and also for domestic food security.

The situation in Samoa added to the general concern among the PGR community, that the Pacific was losing its diversity. Countries were struggling to maintain national field collections because of limited resources, pest and disease outbreaks and climatic extremes.

This concern about losing diversity was recognized at the Ministerial level, and in 1996 the Ministers of Agriculture decided to start, both in their countries and through regional cooperation, policies and programmes to conserve, protect and use their plant genetic resources effectively and efficiently for development.

SPC's Land Resources Division Centre for Pacific Crops and Trees

The Centre for Pacific Crops and Trees (CePaCT), a genebank that uses *in vitro* techniques for conservation, has been the key component of SPC's response to this recommendation since September 1998. The aim of the CePaCT is to assist the Pacific Island Countries and Territories in conserving the region's genetic resources, and to provide access to the diversity they need. Quarantine regulations throughout the Pacific region ensure that virus-tested tissue cultures are a safe method for importing plant material.

Conservation is the core business of the Centre with priority given to the region's staple crops like taro, yam, sweet potato, banana, cassava and breadfruit collections. The taro collection is particularly unique, being the largest collection of taro diversity globally – with more than 850 accessions. In fact the uniqueness of both the taro and yam collections, and its importance for ensuring food security has been acknowledged at international level with the recent signing of a long-term agreement with the Global Crop Diversity Trust. The Trust has agreed to provide funding support *ad infinitum* for these collections – this agreement is the first to be signed with a genebank outside of the Consultative Group for International Agricultural Research Centres (CGIAR).

The Centre not only conserves the region's valuable genetic diversity, but also provides an avenue to safely import “new” diversity into the region, such as the relatively recent acquisition of salt and drought tolerant sweet potato from the international potato centre (CIP) in Peru.

CePaCT ensures that the diversity it conserves is made available for growers throughout the Pacific, often through the Pacific Plant Genetic Resources Network (PAPGREN) – some 5,000 to 6,000 plants are distributed on an annual basis. The importance of access to and availability of diversity has been recognized globally as one of the important tools required to manage a changing climate. The establishment of a ‘climate-ready’ collection is now a new initiative. This collection will provide the farmers of the region with a range of diversity required to sustain food production in a changing climate. Diversity also provides the region with the means to address the problem of lifestyle related diseases. The increase in diseases such as hypertension, diabetes, has been connected to the consumption of nutritionally poor food, often imported. In contrast, traditional food is nutritionally rich and different varieties of crops, such as banana and breadfruit can provide significantly high levels of beta-carotene, an excellent weapon in the fight against these diseases. Finally with the urgent need to establish new markets for trade, diversity can be a key component of the production chain, both through the more conventional way of ensuring continuity of supply, a specific, desired shape, but also because diversity can indeed provide a new product through the development of underutilized species, or “crops of the future” as they are often referred to.

The SPC Land Resources Division, Pacific Agricultural Plant Genetic Resources Network (PAPGREN)

In 2001, the region's Directors of Agriculture endorsed the formation of a PGR regional network, the Pacific Agricultural Plant Genetic Resources Network (PAPGREN). The establishment of PAPGREN is the realization of the PICTs that increased collaboration is crucial, both with regional and international initiatives and organizations. Priority activities of PICT are:

- Develop appropriate management strategies for agricultural PGR in the Pacific
- Promote the safe exchange of germplasm within and outside the region.
- Develop and coordinate documentation of agricultural PGR
- Enhance awareness of the importance of PGR at national and regional levels.
- Assist in the development of national and regional policies to promote conservation and sustainable use of PGR, with adequate sharing of benefits.

PAPGREN includes 17 member countries (American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Fiji, Federated States of Micronesia, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu) and 2 NGOs (Island Food Community of Pohnpei and Kastom Gaden Association of the Solomon Islands). Since 2001, PAPGREN has been conducting a number of activities geared at increasing PGR knowledge and skills at the national level (the list is not complete):

- Short term training (annual) on genebank management and characterization using standardized descriptors (banana, cassava, sweet potatoes and taro) and collection and data storage, analysis and management
- Promotion of the International Treaty on Plant Genetic Resources for Food and Agriculture
- Organize yearly network meeting including NGO participation
- Organize national PGR consultation in selected countries
- Base line assessment of PGR awareness / knowledge (ongoing)
- Development of training materials for Rural Training Centres and schools (ongoing)
- Development of distance learning materials (ongoing)
- Support of pilot research projects and dissemination of information on their impact both on livelihood and on methodology development
- Support of rescue collecting and other priority emergency conservation activities included in the joint policy
- Enhancement of CePaCT outreach to farmers
- Award of two MSc scholarships at the University of the South Pacific

These were made possible with funding from New Zealand Aid and ACIAR and support from Bioversity International.

PGR Education in the Pacific

There are no courses offered specifically for PGR in the region. Students have to enroll at universities outside the region (mainly in the Philippines and England) in order to specialize in the subject.

On a closer look at two of the region's Universities (University of the South Pacific and Papua New Guinea University of Technology), a very small portion of PGR course components are integrated into biology (University of the South Pacific) and agriculture (PNG University of Technology) courses. More specifically for the University of the South Pacific parts of PGR are integrated in the following courses:

- BI 304 – Conservation Biology
- BI 422 – Genetics & Plant Breeding
- BI 442 – Biodiversity & Conservation

SPC staff is invited to lecture (average of 3 hours per semester when the course is offered) at USP, especially in the BI 442 course. The topics mainly cover what PGR is, why it is important, and the different conservation methods. The course mainly consists of lectures and there are no mandatory laboratory or field practicum sessions on PGR.

There is a need to carry out a study about the level and components of PGR topics that are covered in the rest of these courses. Such a study would highlight specific topics and practicum that are currently part of the course and those that need to be added. This is important because it would directly be useful for the students and their career and for their potential employees as well.

As highlighted in the previous section, PAPGREN is in the process of carrying out a number of initiatives to promote PGR education in the region. This is not uniquely aimed at graduate level courses. For instance, the Distance Flexible Learning Course will be offered at the certificate level. This will target field technicians (in the Pacific context, these are officers who have not completed secondary school but are employed in agriculture departments and ministries of governments in the region) and graduates who are already in the work force but would like to either complement their knowledge and skills or branch out into PGR. Other PGR curricula are for farmers and are more hands-on. As in the case of PGR curriculum for schools, an interactive CD will be developed using e-learning and e-teaching methods.

Conclusion and Recommendation

Judging from the very recent history of PGR development in the region, it may be too early for the region to have its own PGR graduate course. It may seem appropriate, logical and cost effective that students who would like to major in this subject enroll elsewhere in Europe and Asia. A good option is also for the PGR course to be made available on the web. This would also avoid the prohibitive relocation-related costs. In addition, the online course should be carried out in collaboration with local universities and organizations such as SPC. This would ensure that thesis, tutorials, practicum and laboratory sessions are properly executed.

On another note, there is still a need to have more students specializing in PGR in the region particularly at the national level. Funding support is required to guarantee that there are a sufficient number of PGR experts in the region and beyond.

Further, current PGR- related courses offered by Universities need to be evaluated and consolidated to strengthen both practical and theoretical knowledge.

Teaching MSc programmes on plant genetic resources: experiences from University of the Philippines Los Baños (UPLB)

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Introduction

The MSc Plant Genetic Resources (MSPGR) programme was first offered at the University of the Philippines in 1998, specifically developed for the Asia Pacific and Oceania region. The programme aims to equip the students with a comprehensive understanding of PGR concepts, principles and strategies for the formal and informal PGR conservation, development and management, and capacity to manage genebanks, living botanical collections, natural reserves and *in situ* conservation areas. The programme also aims to develop broad knowledge and understanding of policy issues relating to PGR conservation and use.

UPLB initiated the development of the MSPGR programme in the early 1980's. Bioversity International (then known as the International Plant Genetic Resources Institute, IPGRI), the Asian Vegetable Research and Development Center (AVRDC) and the International Rice Research Institute (IRRI) provided technical assistance for the development of the curriculum. A survey of the demand for the MSPGR programme in the region was conducted by IPGRI as a requirement for the establishment of the new programme in the university. The proposal was submitted to the Curriculum Committee of the university in 1995 and was approved by the University's Board of Regents in 1997.

The MSPGR programme at UPLB has now been going on for 12 years, but since 2005 enrolment has minimal partly due to lack of scholarships. Therefore, a review of its content and relevance to programmes and institutions other than those in government or CGIAR centers is required.

The MSPGR Curriculum

The MSPGR programme requires a minimum of 24 units of course work with at least 15 units in the major PGR field and 9 units in the minor field. The programme of study includes foundation courses in PGR conservation, plant systematics, seed technology. General genetics, introductory plant breeding and elementary statistics are pre-requisites.

Students in the MSPGR programme may choose any of the following disciplines as their minor field of specialization: agronomy, anthropology, biochemistry, botany, entomology, environmental science, forestry, genetics, horticulture, plant breeding, plant pathology, plant physiology, sociology and statistics. The students enroll for two semesters and one summer.

Development of core courses

Three graduate core courses were developed specifically for the programme: Assessment of Diversity in Plants; Methods of PGR Conservation, and Documentation of PGR Information. The three core courses were developed through consultations and workshops with various staff of the university and IPGRI, with expertise in different disciplines related to PGR conservation and management (cytogenetics, biochemistry, molecular genetics, seed science and technology, tissue culture, plant physiology, plant pathology and entomology, etc.).

Before the initial offering of the programme, a series of workshops were undertaken to flesh out the course syllabi approved by the University Council. The workshops also aimed at retooling the professors on PGR conservation and management. The lecture and laboratory syllabi for the three courses were then drafted and finalized by the pool of experts.

Management

The MSPGR programme is managed by the Admissions and Management Committee which is composed of representatives from relevant units of the university, namely College of Agriculture, College of Arts and Sciences and College of Forestry and Natural Resources. This is an effective operational system to evaluate incoming students which are new to the programme and to disseminate information about the MSPGR programme to the different colleges of the University.

Enrolment trends

The highest number of applicants (16) to the programme was in 2000, of which only 8 enrolled. This was when Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) and IPGRI provided scholarships for the MSPGR programme (Table 1). Enrolment has decreased since 2005.

Among the 27 students that have enrolled to the program, five did not continue and one transferred to the MS Plant Breeding Programme with PGR as his minor field of specialization.

Table 7. Number of students enrolled and graduated in MSPGR program, 1998-2008.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Enrolled	2	3	8	4	4	0	4	1	0	0	1
Graduated	0	0	2	4	6	0	0	1	4	1	3

Status of the MSPGR programme

There are 21 graduates of the MSPGR programme (Table 2). The graduates are from 8 countries, namely Bangladesh (1), Fiji (1), Indonesia (2), Myanmar (1), Pakistan (1), Philippines (12), Thailand (2) and Vietnam (1). There were also 28 students (19 MS and 9 PhD) who graduated with PGR as their minor field of specialization. There are still 11 students who have PGR as their minor field of specialization.

Table 8. Number of major and minor students in the PGR program, 1998-2009.

	Number
MSPGR graduates	21
MSPGR (on-going)	4
MS PGR (did not continue)	6
MS minor in PGR graduates	19
MS minor in PGR (on-going)	4
PhD minor in PGR graduates	9
PhD minor in PGR (on-going)	7
PhD minor in PGR (did not continue)	1

Impacts

The theses research conducted by MSPGR students has contributed to new knowledge on conservation and management of plant genetic resources. A lot of this research has been published in refereed journals. The hands-on laboratory experiences enabled the students to conceptualize, carry out research and write scientific papers. Posters and papers were also presented in scientific meetings.

A requirement of the courses is that students have to develop their team work skills to successfully conduct the laboratory exercises. This is a very positive aspect, as PGR students observed and this has been confirmed by a survey of the programme.

Within the university, the instruction function of PGR conservation and management goes hand in hand with its research function.

After the establishment of the MSPGR programme at UPLB, several other State Universities and Colleges (SCUs) in the country also started offering a course on PGR conservation and management. In many cases, the subject is offered as an introductory undergraduate course. In one case, it is offered as a graduate course. There is a plan to standardize at least the introductory course offered by all SCUs to provide students with the same initial level of knowledge on PGR conservation and management.

Limitations and challenges

The team teaching approach was agreed to be the mode of delivery for the courses to provide students with the technical and practical know-how of the various disciplines. Nevertheless, this approach also has its limitations, and many students have suggested to reduce the number of professors handling each course.

Through several years of student evaluation, some other limitations and strengths in the way the core courses are being taught have emerged. In the course on assessment of diversity, students recommended that characterization and evaluation of PGR should be dealt with in separate courses. Most of them felt that the current course on both characterization and evaluation is too demanding.

The programme lacks a course on laws and policies on PGR conservation and use. Relevant laws and policies are partly discussed as an additional topic in a PGR conservation course. The current programme does not include a course on enhancement of PGR. There is a need to address this topic at the interface between conservation and use. Topics on economic botany and discovery of novel products should be incorporated as well.

The enrolment to the programme was largely scholarship-driven. The termination of the scholarship grants by IPGRI and SEARCA significantly decreased the enrolment. The demand for MSPGR graduates based on survey results from 1995 may have been overestimated.

The MSPGR programme at UPLB is a two-year program. This is longer than those offered by other universities in the region. The programme requires foundation courses which have pre-requisites, thus further prolonging the time for completion of the programme if incoming students have not taken the foundation courses in their baccalaureate degree programmes. The strength of the program, however, is that it ensures that the graduates have the solid foundation which is necessary to conduct independent research.

Although enrolment to the programme has decreased, students from other degree programs (MS and PhD) have taken PGR as their minor field of specialization or included PGR courses in their programme of course work.

SESSION 1

Teaching MSc programme on plant genetic resources: experiences from Universiti Kebangsaan Malaysia and feedback from students

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Introduction

Plant genetic resources (PGR) are the biological basis of food and other essential uses for an increasing human population and, directly or indirectly, support the livelihood of every individual on earth. PGR are part of the biodiversity that nurture people and encompass the diversity of genetic materials in both, traditional varieties and modern cultivars, as well as wild relatives of crops and other natural plant species used as food. They are also the main source of raw materials for modern medicines such as antibiotics, heart drugs and painkillers, and deliver raw materials to sustain a variety of other industries. Malaysia is one of the “megadiversity” countries of the world with an impressive amount of tropical genetic resources, agricultural crops and also huge forest resources.

The interest in management of PGR is increasing because of its relevance in efforts to develop agriculture, food production, forestry, pharmaceutical and other related downstream industries, and efforts in sustainable environmental management. Plant breeding programmes use PGR as sources for resistance against plant diseases and pests, quality traits and for increasing the variety of food products. Hence, management of all aspects of PGR, i.e., from collection, conservation to utilization is important to guarantee the successful management of natural resources for current and future use.

The MSc PGR programme at University Kebangsaan Malaysia

In order to strengthen the education and research on PGR, an *ad-hoc* committee was set up by UKM for the faculty to offer a fulltime graduate programme, the MSc Management of Plant Genetic Resources. The course was intended to be internationally focused and be offered in collaboration with the International Plant Genetic Resources Institute (IPGRI), now Bioversity International, to impart high-level theoretical and practical skills that are required for promoting sustainable utilization of plant genetic resources. The *ad hoc* committee included members from leading national research institutions such as the Palm Oil Research Institute of Malaysia (now the Malaysia Palm Oil Board, MPOB), the Rubber Research Institute of Malaysia (now the Malaysia Rubber Board, MRB), The Malaysia Agriculture Research and Development Institute (MARDI) and the Forest Research Institute of Malaysia (FRIM). IPGRI played a pivotal role in the establishment of the Master Programme, at the time when its office just moved from Singapore to Malaysia. The new MSc programme was first offered in 2000.

The programme is carried out as an international programme, with co-operation from Bioversity, with the aim of providing theoretical expertise and pertinent practical skills required for the sustainable management of PGR. The educational expertise of Universiti Kebangsaan Malaysia (UKM) is complemented by a vast experience of leading national research institutions such as FRIM, MPOB, MARDI, MRB, and the Nuclear Agency of Malaysia. Their experienced staff provide relevant inputs in conducting the programme. The strong collaborative element between the university and the national research institutions brings flexibility and practicality to the teaching approach and consequently ensures the success and relevance of the training.

Entrance requirements

Prospective candidates should possess a good first degree in biological sciences (or the equivalent in biology, genetics, plant breeding, horticulture, agronomy or agriculture). Candidates well qualified in any other related field may also be considered, provided they have experiences considered relevant to the field of study. Proficiency in English is a requirement.

Programme structure

The MSc PGR programme is based on coursework, requiring 12 months (2 semesters). Candidates are required to complete a total of 36 units, comprising 12 units of core courses and 12 units of elective courses and 12 units of research (Table 1). Candidates are encouraged to expand their individual interests through research projects which commence in the first semester and are supervised by UKM academic staff together with experts/scientists from relevant institutes. Candidates are required to submit their research project reports at the end of the second semester for examination.

Table 9. Courses offered in the MSc PGR programme.

Semester	Core Courses	Elective Courses	Total Units
I	STPD6014 Research methods STAP6073 Environmental management system STAP6043 Diversity and plant systematic STAP6974 Research project I	STAB6903 Diversity of plant genetic resources	17
II	STAP6032 Biogeography STAP6988 Research project II	STAB6913 Plant breeding STAB6923 Advanced plant biotechnology STAB6143 Economic botany and ethnobotany	19
Total units	24	12	36

Core courses contents

STAB6143 - Economic botany and ethnobotany

The course covers the general aspects of plants of economic importance. These groups of plants include the food and industrial crops, forest species, medicinal plants, and ornamentals. This course examines the history of plants used by man, especially the biological, environmental and socio-economic considerations in selecting the economic crops. The exploitation, botany, agronomy and production of cereal crops, pulse crops, oilseed crops and plantation crops are emphasized.

STAB6903 - Diversity of plant genetic resources

The course covers various topics on plant diversity, with emphasis on important plant species, including forest species, that are used for food and agriculture, industrial biomaterials and medicines. Diversity between and within plant species for major, minor and underutilised crops will be discussed. Important aspects include general principles of diversity and evolution, centres of origin and diversity, genepools, breeding systems, value of plant diversity and their use in breeding modern varieties. The course also covers developments in molecular marker technology and applications in PGR assessment and utilization. It also includes field visits.

STAB6913 - Plant breeding

The course covers both crop improvement and tree breeding. Topics on crop improvement include genetic principles of breeding and improvement of crop plants; plant genetic resources; breeding systems; host-pathogen interactions; genetics of resistance and pathogenicity; monogenic and polygenic inheritance; heritability; heterosis; ideotype; hybridization and selection; mass selection; pedigree selection; backcrossing; inbreeding; hybrid varieties; resistance against pest and diseases; genotype-environment interactions and applied cytogenetics; physiological breeding; gene manipulation; and, genetic engineering in relation to their use in plant breeding.

Topics on tree breeding include genetic principles in breeding and improvement of forest species in relation to production forestry; tree improvement strategies; selection methods; seed production area; seed orchards; genetic testing programmes; reproductive biology and advance in propagation technology; hybrids in tree improvement; wood and tree improvement; advanced generation selection; gains and economics of tree improvement; and, applications of biotechnology in tree improvement.

The course also covers population and quantitative genetics which are closely related to plant breeding.

STAB6923 – Advanced plant biotechnology

The course gives an introduction and overview of important biotechnologies and explores the ways in which new biotechnologies can contribute and be applied to crop improvement or tree breeding programmes. The biotechnologies include genomics and bioinformatics, mapping plant genomes with molecular markers, transformation systems, analysis of transgenic plants and applications of plant genetic manipulation. Practical classes given are primarily associated with the current genomic tools and genetic manipulation techniques used in crop and tree improvement. It includes visits to biotechnology laboratories.

Significant milestones

The programme was first offered in 2000 by the School of Environmental and Natural Resource Sciences (PPSSSA). It became the second programme based on coursework introduced by the school (the first being the “Master of Science in Conservation Biology”, which is popular and has maintained strong enrolment).

The MScPGR Programme at UKM was initially conducted based on four course modules: Plant Exploration, Genetic Diversity, Plant Conservation, and Plant Utilization of 7 weeks each (Lindsey et al., 2002). Eight students enrolled during the first intake in 2000, but only two in the second intake in 2001. Indeed, the programme went through trying times; many claimed that it would not be tenable to continue because of the poor intake and response.

After two years, in May 2002, the programme structure underwent major changes. These were necessarily undertaken and streamlined when the faculty began planning to introduce the new “Master of Science by Coursework” to complement the already existing “Master of Science by Thesis” as a strategy to increase post-graduate enrolment. Essentially, courses were no longer packaged into modules, thus allowing the programme to start from any semester.

With the new and streamlined programme structure, the courses of the “MSc in Management of Plant Genetic Resources” now become elective courses for post-graduate students at the eight other “Master of Science by Coursework” programmes of PPSSSA, as listed in Table 9 above.

For the period 2000-2009, the course enrolment in the programme by semester is shown in Table 4. Overall, there has been a steady and gradual increase in enrolment for the courses as well as for the programme.

Second semester course enrolment has increased significantly since the programme structure had been modified. This trend indicates that there has been an increase in the number of students who opt to enrol in the MScPGR Programme after their graduation.

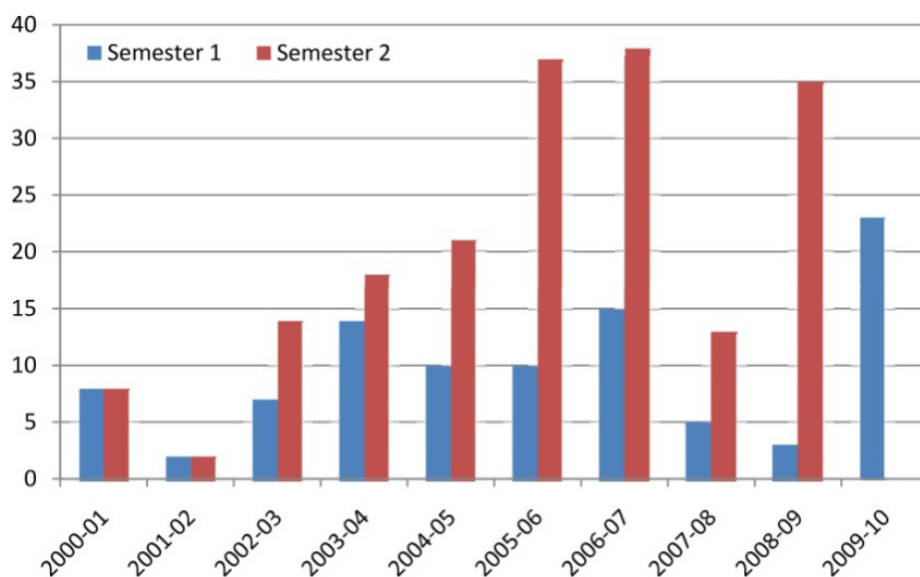


Figure 3. Course enrolment in the MScPGR Programme according to semester, 2000-2009.

Feedback from students/stakeholders of PGR programmes and courses

The feedback from the first batch of students indicated that the courses and materials were good, but the module schedule was very demanding. Completing courses in only 7 weeks was very rushed. There were also problems with scheduling guest lecturers in such a short time. In 2001, the modules ran on the same schedule as the normal UKM semesters, each one being 14 weeks long. Modules 1 and 2 occurred simultaneously in one semester, as did modules 3 and 4. This approach gave both the students and lecturers more time to work with the materials and topics.

Starting in May 2002, the programme structure underwent further changes and was streamlined with other newly created “Master of Science by Thesis” programmes so that now there is a common structure. Postgraduate students enrolled in the School of Environmental and Natural Resource Sciences would take a set of core courses and then chose their elective courses depending on the specific programme they would like to graduate from. This made the programmes easier to administer and allowed more students to take elective courses outside their major field of study. These changes also put more weight on the research component of the programme.

The major constraint faced by the MScPGR programme at UKM right now is the rather poor student enrolment. The programme has been around long enough but it is still wanting and needs to gain more public awareness and a reputation in the academic and professional circles. There is a need to make undergraduate students more aware of and interested in the programme as well as making potential employers more aware of the benefits of hiring a graduate of the programme.

Biodiversity International could further contribute to the curriculum development of the programme by reviewing the materials/resources for the courses and suggesting areas for improvement, where needed. This has occurred already but it should be continued and improved. It would also be beneficial if a network like the one established by University of Tsukuba, Japan in collaboration with Biodiversity International could assist in highlighting the MScPGR Programme and also in increasing the public awareness among prospective students and relevant stakeholders.

A small number of students enrolled in the programme with the support of PTPTN loans, but many self-financed their own education. The majority of the students completed the programme after one year, but there were cases where the programme duration had to be extended to 1½ years, particularly due to inadequate time to complete their research projects. A total of 23 students have successfully graduated from the programme since 2001 (10 years), while 9 are still completing their studies.

The following feedback on their vocations has been reported from the graduates of the MScPGR Programme:

- Teachers in secondary schools (e.g. KPLI)
- Lecturers in universities (e.g. UiTM, Unisel, UTAR)
- Lecturers in colleges, such as matriculation colleges and teachers' training institutes
- Scientists in research institutes (e.g. MARDI)
- Management executives (e.g. in commercial plantation companies)
- Sales executives (e.g. biotechnology trading companies)
- Private enterprises or organizations
- Pursuit of higher academic degrees

The following needs and imperatives have been mentioned with respect to the importance and contributions of the current MScPGR Programme to the national agenda:

- Dwindling number of competent plant breeders, agronomists and other agricultural scientists
- Boosting agriculture as the third engine of growth for Malaysia
- New faculties of agriculture established by universities (e.g. Faculty of Agriculture and Biotechnology – UDM, School of Sustainable Agriculture – UMS, Kulliyah of Agriculture and Natural Resources – UIAM)
- National Information Sharing Mechanism (NISM) on the Implementation of the Global Plan of Action (GPA) for the conservation and sustainable utilization of plant genetic resources for food and agriculture in Malaysia.

Future scenario

UKM has initiated efforts towards certification of standards and accreditation of academic programmes, including the MScPGR Programme, consistent with the Malaysian Qualification Frameworks (MQF), as described in Appendix 1. The MQF is designed to be a unified system of qualifications offered on a national basis by all educational and training institutions which include colleges, universities, vocational institutions, professional organizations and other higher educational institutions in both the public and private sector as well as workplace training and lifelong learning experiences. MQF secures the standards of qualifications and reinforce policies on quality assurance.

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Appendix 1.

Towards certification of standards and accreditation of the MScPGR Programme consistent with the MQF concepts:

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

The Management of Plant Genetic Resources Programme provides an interdisciplinary curriculum with the aim of producing graduates with strong theoretical expertise and practical skills required for the sustainable management of plant genetic resources. This programme is taught by members of the faculty, and coupled with significant collaborative inputs from Bioversity International and many leading national research institutions such as FRIM, MPOB, MARDI and MRB. This approach offers graduates opportunities to pursue a wide range of career options in the management of plant genetic resources relevant to agriculture, forestry, biotechnology and related downstream activities. It is also targeted at working professionals wishing to further their scientific knowledge for research and teaching.

PROGRAMME LEARNING OUTCOMES (PLO)

After completing the Programme, graduates should be able to:

1. Master the basic knowledge in plant genetic resources, their conservation, use and management, and related disciplines.
2. Able to apply theoretical expertise and strategies for plant genetic resources from their conservation to utilization.
3. Able to identify problems in management of plant genetic resources and solve the problems effectively.
4. Able to undertake a plant genetic resources related works effectively as an individual and in teams.
5. Able to communicate effectively verbally and in writing with the scientific community and the public in addressing local and global issues related with plant genetic resources.
6. Are competent in using current literature and appropriate research methodologies, and contribute new information to management of plant genetic resources.
7. Able to understand in-depth different plant genetic resources, diversity, importance, impacts and their use.
8. Understand problems and use best practices in the management of plant genetic resources.
9. Acquire knowledge and skills in entrepreneurship and management to develop and commercialize research findings.

SESSION 2.
VIEWS AND
FEEDBACK FROM
PGR STAKEHOLDERS:
EMPLOYERS AND
STUDENTS

SESSION 2

International career development in plant genetic resources and plant breeding: A discussion at Japan science council meeting in 2008

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Education and career development on plant genetic resources, and plant breeding as educational disciplines in Japan was discussed at a meeting sponsored by the Japan Science Council in September, 2008.

Major issues discussed were:

- Weakness in systematic programmes oriented towards agriculture and agricultural industry, especially on agriculture business and entrepreneurship.
- Lack of a visible system for international careers.
- Substantial shortage in professorial human resources in agriculture, and limited competitiveness in international agriculture.
- Low motivation of younger generations for working in agriculture and for pursuing an international career development
- Slow progress in internationalization of Japanese academic institutions.

After the meeting and further rounds of discussion, the Education Ministry of Japan (MEXT) has launched a programme for the internationalization of Japanese universities in 2009, the 'G-30 Programme'. It aims at alleviating the above-mentioned issues.

Within this supportive framework, a dozen universities, including University of Tsukuba as the key university for internationalization, are now seeking to elaborate their own educational programmes, including plant genetic resources and plant breeding, as international education and career development.

Environmental challenges with local stakeholders: 3 E-forum at Tsukuba

KAZUO WATANABE

UNIVERSITY OF TSUKUBA, JAPAN

In December 2007 the University of Tsukuba proposed the Tsukuba Eco-City Initiative as a core plan for coordination and collaboration at the Tsukuba Science City, Ibaraki, Japan. Tsukuba Science City consists of more than two hundred research and technology institutions from different sectors of the high technology industry. These institutions can be both a cause of environmental concerns and also an instrument for remediation. Key organizations agreed to participate in, and implement the proposed plans. Examples are: The local governments of Tsukuba City, the Ibaraki Prefecture, Advanced Institute on Science and Technology (AIST), the National Institute of Environment (NIE), the National Institute for Materials Science (NIMS) and University of Tsukuba (UT).

The basic concept of the Eco-City Initiative are:

- The themes of activities shall be based on the common agenda of Tsukuba Science City.
- Encouragement for participation of various organizations with different specializations.
- UT shall have the institutional commitment as the core of the Initiative.
- The plan and activities should conform with the Science and Technology Policy of the Japanese government.
- The plan and activities should also meet with the third stage development plan of Tsukuba City.

The plan is made up of four subprograms:

1. Tsukuba Environment-Energy-Economy (3E) Program
The programme is targeted at the development of technology and systems for improved energy-efficiency, clean energy generation and an energy-efficient city planning.
2. Environmental Conservation Model Program
The programme is aimed at the creation and trial of environmentally friendly technology and systems for the local model society, including resource recycling and a stimulating coexistence of different activities.
3. Education, Culture and Health Model Program
This component is oriented towards the development of a residential system with respect to maintenance and improvement of health, education, culture, and local, cultural heritages.
4. Rejuvenation of City Function Model Program
Tsukuba's city planning is discussed and formed with the participants to ensure safety in living, low pollution, energy-efficient transport systems and disaster information systems.

Following the planning and implementation, Tsukuba Science City will be restructured as a national and maybe even global model for an environmental-friendly city with strong science & technology and science education functions.

After the initiation of the four programs, the 3E forum has already started, and the other three initiatives will follow swiftly.

The 3E forum has an ambitious target: Tsukuba Science City is supposed to reduce its carbon dioxide exhaustion to 50% of the present level by 2030. If the model is successful these efforts should encompass the whole nation in 2030 to 2050.

The Science City shall make integrative efforts to coordinate and stimulate collaboration between stakeholders. Various institutions with distinguished science and technology capacity will work as a team to recommend and demonstrate the essential technology and systems for achieving the goal making the city environmentally friendly. This model integration of technology and knowledge is a vision for creating a “low carbon emission society” and the model could be introduced into global communities.

Experiences on PGR training from the perspective of genebank management

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NIAS Genebank

The National Institute of Agrobiological Sciences (NIAS) Genebank is the central coordinating institute in Japan for conservation of plants, microorganisms, animals and DNA materials related to food and agriculture. The NIAS Genebank manages its activities in collaboration with sub-banks located all across Japan, with NIAS acting as the central bank.

The NIAS Genebank has collected plant genetic resources (PGR) in Japan and overseas. The collected genetic resources have been classified, evaluated, multiplied and preserved. The genetic resources in the public domain are distributed to users together with relevant information for breeding, scientific studies (including genome research) and educational purposes.

The plant section of the NIAS Genebank covers the following 12 plant groups:

Rice, Wheat and barley, Legumes, Root and tuber crops, Millets, Other cereals, Industrial crops, Grasses and forage crops, Fruit trees, Vegetables, Ornamental flowers and trees, Tea, Mulberry, and Tropical and subtropical crops.

The total number of newly registered PGR amounts to over 5,000 accessions per year, including items obtained by exchange with domestic and overseas research institutes. The seeds are long-term preserved in a low-temperature and low-moisture environment. The number of registered items is about 243,000 as of 2008.

Training at the NIAS Genebank

The NIAS Genebank project has cooperated and will cooperate with Asian countries and several international organizations. Under the joint auspices of JICA, a group training course on PGR is held annually at NIAS for foreign researchers. The course duration is about six months. During the initial two weeks of the course, lectures about exploration, preservation and data management are provided for all trainees. After the common lectures and practices, trainees are assigned to the host laboratories to receive individual training.

In this paper, we introduce the outline of the lecture for data management. The lecture is useful for trainees to understand the overall genebank activities and management, because the genetic resource database has been built based on information collected during exploration, evaluation and conservation management in the NIAS Genebank.

PGR training of data management on the JICA group training course

Information on the history and properties of the registered genetic resources is added to the database from time to time and is made open to the public through the Internet. The database can be searched by properties, and information on any genetic resources with the desired properties can easily be obtained.

The database system consists of a PGR database for data management and web database for the website. A part of the data from the PGR database is transmitted to the web database. The schematic diagram of the NIAS Genebank database system is shown in Figure 4. There are three major data sets in the genebank database system: passport data, storage data and characteristics/evaluation data. The germplasm accession number is a key descriptor linking these data sets. Accession numbers are assigned when passport data is entered into the database.

The warehouse of the active collection installed at the central bank uses a robot system. The input of the address code accesses the storage data and enables the robot to bring the bottle of seed to the seed preparation room.

The characteristics/evaluation data consists of information such as morphological, physiological characteristics and reaction to stress on 125 evaluation crop groups. We have developed a data management method for PGR to register and retrieve the characteristics/evaluation data efficiently. This method manages the data generated by a characteristics/evaluation search as metadata. The user can access the metadata via a specific interface that generate electronic files of the characteristics/evaluation search.



Figure 4. Schematic diagram of the NIAS Genebank database system.

The workflow for multiplication is displayed in Figure 5. The rounded white rectangles and the yellow rectangles symbolize the operations for seed multiplication in the central bank and the data management program, respectively. Each operation is registered in the PGR database through the program. The workflow of distribution is shown in Figure. 6. The distribution process is also registered in the database.

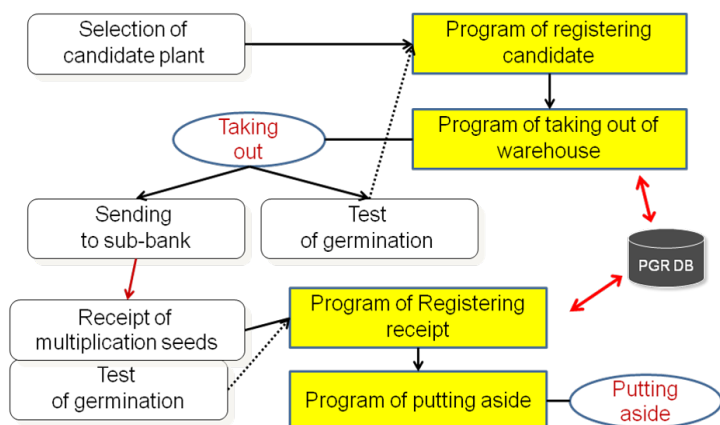


Figure 5. Workflow of multiplication.

In the central genebank, the operator uses a client computer to access the application server. The data management programme allows the input of PGR data into the database on the application server. The schematic diagram of the database system in the central bank is shown in Figure 7. In the sub-banks, an operator can access the sub-bank server through Internet. The data management programme for the sub-bank is operated on the sub-bank server. The schematic diagram of the database system in sub-banks is shown in Figure 8.

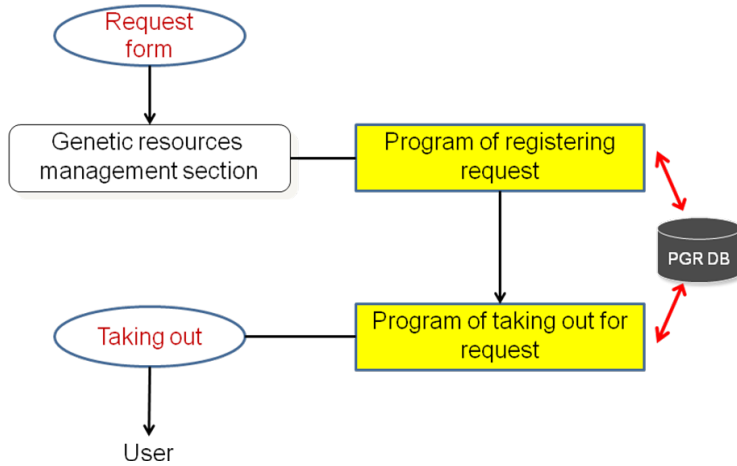


Figure 6. Workflow of distribution.

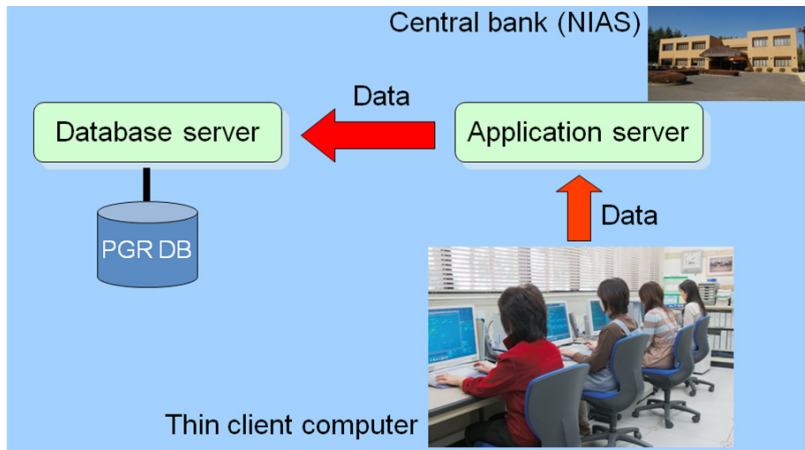


Figure 7. Schematic diagram of the database system in the central bank.

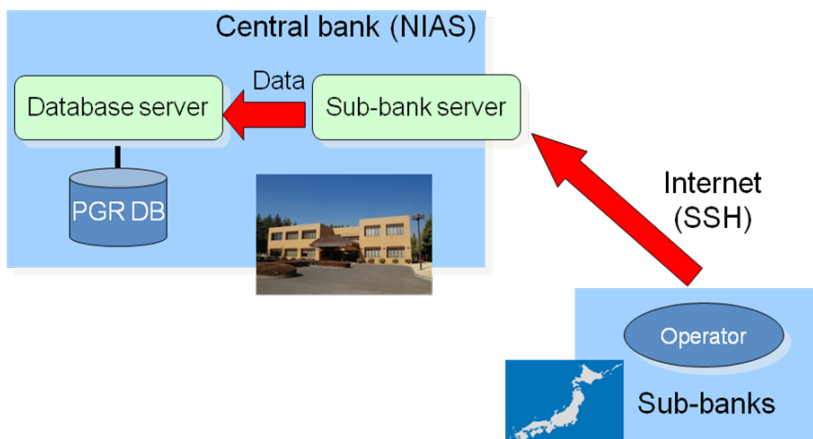


Figure 8. Schematic diagram of the database system in sub-banks.

The NIAS genebank can be accessed at <http://www.gene.affrc.go.jp/>. The website content includes an introduction in the NIAS Genebank, databases, distribution, manuals and links.

The PGR conserved in the NIAS Genebank can be searched according to passport data and evaluation data queries. An example of a search result of evaluation data queries is shown in Figure 9.

Image data are very helpful for users to familiarize themselves with the physical appearance of genetic resources. The NIAS Genebank provides images and characteristics of rice, legume, vegetables, flower and ornamental plants, millet and forage crops, chicken, and silkworm. An example of an illustrated genetic resources database is shown in Figure 10.

We have developed some content for use in genetic resources research such as web-based search and map display system, NIAS core collection, marker information, and a Japanese plant diseases database. The top page of marker information and the login/registration form is shown in Figure 11. Azuki bean (*Vigna angularis*) SSR information (196 primer) and Black gram (*Vigna mungo*) SSR information (61 primer) are available now.

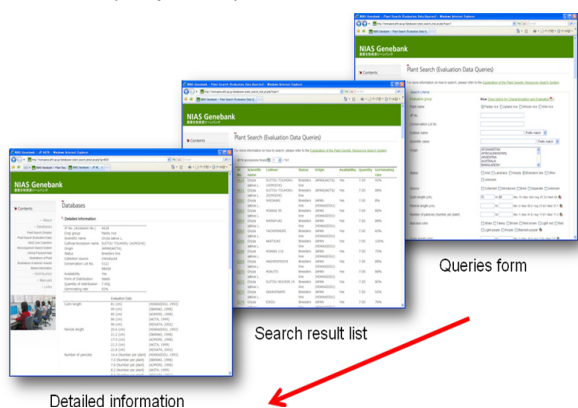


Figure 9. An example of a search result of evaluation data queries.

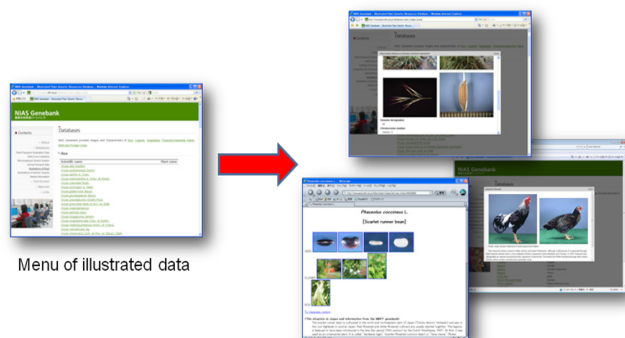


Figure 10. Illustrated genetic resources database.

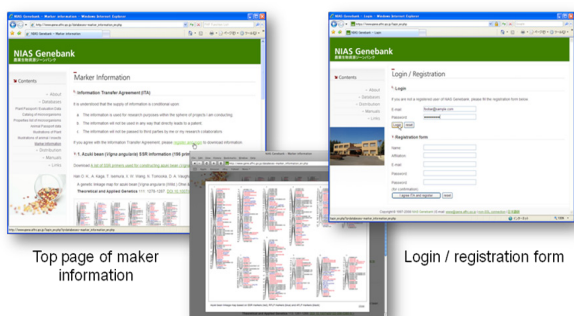


Figure 11. Marker information.

Feedback from students: A survey of graduates of the post-graduate PGR programme at UPLB

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Introduction

Since its establishment in 1997, the MSc degree in PGR Conservation and Management (MSPGR) programme has been part of the curricular offering of the University of the Philippines Los Baños (UPLB). The programme has accepted students pursuing any of the following options:

1. The Master of Science degree in PGR Conservation and Management (MSPGR) as the major field of specialization
2. As the minor field of specialization in any of the related degree programmes, e.g.
 - Master of Science in Plant Breeding
 - Master of Science in Genetics
 - Master of Science in Entomology
 - Master of Science in Horticulture
 - Master of Science in Forestry
 - Master of Science in Rural Sociology
 - PhD in Plant Breeding
 - PhD in Genetics
 - PhD in Forestry

In addition, students of other related disciplines have enrolled in any of the courses offered by the PGR programme as part of their programme of course work (e.g. genetics, agronomy).

Twenty-one major students have graduated from the PGR programme and 28 graduates had chosen PGR as their minor field of specialization. To determine the perception of the PGR degree programme from the point of view of the graduates and to assess the contribution of the degree programme to the employability and effectiveness of the graduates in their work/employment, a survey was conducted in 2009. The survey targeted the graduates from UPLB who completed the MSPGR, or who had chosen PGR as their minor field of specialization.

Methodology

A list of all graduates with PGR as their major or minor field of specialization was made. A survey questionnaire was prepared, containing the following items:

- a. General information about the respondents
- b. Educational background of the respondents
- c. Choice of educational institution and degree program
- d. Knowledge acquired from the degree program
- e. Further studies
- f. Employment data
- g. Job transition and relevance of degree program

The survey focused only on students who had graduated to elicit valid responses on the applicability and effectiveness of PGR education in their choice of employment. Students currently enrolled were not included in the study. The survey questionnaire was sent out to the respondents via electronic mail. The responses were then collated and analyzed.

Results and discussion

Respondents' profiles

A total of 22 respondents participated in the survey, 13 of whom are female and 9 are male. There were 15 respondents from the Philippines, two each from Bangladesh and Myanmar, and one each from Indonesia, Lao PDR and Thailand. Seventeen and five of the respondents pursued their Master's and PhD degrees, respectively. Twelve and 10 respondents had PGR as their major and minor field of specialization, respectively. The fields of specialization of those who minored in PGR were horticulture, plant breeding, genetics, rural sociology and forestry.

Choice of degree programme and educational institution

The respondents were asked to rank their reasons for pursuing the PGR programme in order of relevance. Six respondents said their primary reason is that they were provided a scholarship, four indicated a strong passion for the profession, three mentioned their prospect for immediate employment and two considered the relevance of their chosen field. Other reasons given for pursuing the PGR programme were their high grades in courses or subject areas related to the program, the availability of the degree programme in the school of their choice, affordability to their family, their desire to obtain a prestigious job, the influence of their previous jobs or their adviser, and the requirement of their country.

For their secondary reason, four respondents cited their strong passion for the profession, and three each indicated the availability of the course in the school of their choice, and the influence of their peers and friends.

Based on highest ranking and most cited reasons, the respondents chose strong passion for the profession, being provided a scholarship, availability of the degree programme in the school of their choice, the prospect of immediate employment, and the influence of their peers or friends as the determining factors for their decision to pursue the PGR degree program. It is evident that the availability of scholarships and their passion for the profession are the major determining factors for the students to pursue the postgraduate degree program.

A great majority (21 out of 22 respondents) said UPLB was their first choice of school. Nine of them cited UPLB's reputation as an excellent academic institution as their principal reason for their choice; four cited its reputation as a renowned research institution, three cited its reputation in the field of study, and two said they were required to enroll in UPLB. Other reasons given included UPLB's proximity to the place of employment, the high employability of graduates, and the desire of the student to improve his/her English language skills. It is clear from the responses that the reputation of UPLB as a learning and research institution was the determining factor for their choice.

The main sources of information for the respondents in the choice of UPLB and the PGR programme are their employers/supervisors, colleagues, the Ministry of Agriculture or a CG center (11 respondents), friends, classmates or parents (10 respondents) and the media (5 respondents). It is clear from the responses that the main source of information about the postgraduate programme is still through the professional/institutional and personal route, and that the media plays a lesser role as source of information.

Table 10. Knowledge and skills obtained from the PGR degree programme.

Knowledge and skills obtained	Extremely satisfied	Very satisfied	Somewhat satisfied	Not very satisfied
Specialized knowledge in agriculture and natural resources	9	13		
IT skills	1	9	9	3
Proficiency in written English		13	4	
Proficiency in spoken English		13	5	
Interpersonal communication skills	4	16	2	
Creative and critical thinking skills	8	12	2	
Analytical skills	8	11	3	
Problem solving skills	5	11	6	
Learning to work with others in a group	11	10	1	
Exposure to general knowledge and current issues	8	12	1	

Knowledge and Skills Acquired from the PGR Degree Programme

When asked to evaluate the knowledge and skills obtained from the PGR degree program, the respondents gave the following answers (Table 10). The respondents indicated the highest satisfaction with learning to work with others in a group, specialized knowledge in agriculture and natural sciences, critical thinking and analytical skills that they acquired from the postgraduate program. The lowest rank was given to IT skills acquired. All 22 respondents indicated that they would recommend the PGR postgraduate programme to friends, colleagues and relatives.

Further studies

After finishing the PGR postgraduate program, six of the 16 respondents who completed their MS degrees went on to pursue their PhD degrees, and one completed another MS degree. All seven of them pursued areas of study similar or related to the PGR program, namely: biodiversity/agrobiodiversity/PGR conservation, seed biology, development research, breeding and genetics. Four of these respondents wanted to enhance their credentials and improve their job prospects, and two expressed strong interest in seeking further knowledge.

Employment

Twenty of the 22 respondents are presently employed. The two who are not are undertaking further studies (PhD) in areas related to PGR conservation. Sixteen of the respondents are in institutions within their national governments (11 in research agencies within ministries, 6 in research and instruction agencies in state universities) and 3 in CG centers. Seventeen of them hold regular or permanent positions.

Thirteen indicated that they are in research, three are in research and education, two are in technical or professional positions, and two are government officials. All of the agencies in which they are employed are undertaking research, development, extension or education activities.

After completing their degree programs, 17 of the respondents went back to the institutions that employed them before and during their studies (16 in new designation) and 4 found new employment.

The observed pattern of employment is most likely influenced by the following:

- the scholarship awards given to those who are already in government service,
- the discipline/field of study is applicable to R&D and in some cases educational institutions which are either in the government or are CG centers.

There was only one respondent in a private (partly self-owned) company and none in private academic or research institutions (one graduate who is with a private seed company is not among the respondents).

When asked to rate their ability to perform their current job after completing their postgraduate programs, the respondents gave the following rating (Table 11).

Table 11. Ability to perform their current job after completing the PGR degree programme.

Competence area	Excellent ability	Good ability	Somewhat good ability	Weak ability
Workplace adaptability	9	13		
Problem-solving and decision-making skills	7	11	2	
Confidence to perform required tasks	9	10	1	
Working in a team	9	10		
Communication skills	8	12		
Using information and communication technology	3	12	5	
Technical skills	6	12	1	

The respondents rated workplace adaptability, confidence to perform required tasks and working in a team as the abilities in which they the excelled most when performing their jobs after completing their postgraduate programme. They considered using information and communication technology as the ability in which they least excelled after completing the programme.

Job transition

Thirteen of the respondents indicated that their present job or designation was the first job they held after completing their postgraduate program, while seven said that they had other employment. The major reasons mentioned for staying on the job were career challenge, the job was related to their course or programme of study or their special skill, and the salaries and benefits of the job.

Sixteen of the respondents indicated that their first job was related to the PGR postgraduate program, three said that it was not. Eighteen of them held professional, technical or supervisory positions, and one had a managerial or executive position.

Ten of the respondents considered the PGR postgraduate programme as extremely helpful to their jobs, eight said it was very helpful while one considered it somewhat helpful. Of the competencies acquired in the program, they considered technical skills, critical thinking skills and human relation skills as the most useful.

Fourteen of the respondents were not looking for another job. Of the six who were, the main reasons given were a higher salary or the opportunity to take up a position commensurate with their qualifications, job security and a more challenging job than the one they presently held. Six respondents indicated that they were seeking employment outside of their countries, while 12 said they were not.

Conclusions

One major reason for students for pursuing the PGR postgraduate programme was the availability of scholarships. It was also significant that the other major reason was the students' strong passion for the profession. Strategies to encourage enrolment in addition to scholarships may be necessary.

The PGR postgraduate students were very definite about UPLB being their first choice, citing its reputation as an excellent academic and research institution and its reputation in this field of study.

Major sources of information regarding the postgraduate programme were institutional and inter-personal. The media played a lesser role in information dissemination about the postgraduate program.

Graduates were most satisfied with learning to work with others in a group, and specialized knowledge in agriculture and natural sciences. They were least satisfied with IT skills. Once they were employed, the graduates ranked workplace adaptability, confidence to perform required tasks and working in a team as the abilities in which they excelled the most.

Majority of the graduates were employed by national research or academic institutions prior to and after finishing the PGR postgraduate program; others were employed by the CGIAR centers. Very few were employed or associated with the private sector. This may reflect the current focus of the programme on conservation and diversity assessment, which may not necessarily be within the priorities of the private sector.

SESSION 2

SESSION 3.
REGIONAL AND
INTERNATIONAL
OUTLOOK REGARDING
CONSERVATION & USE OF
PLANT GENETIC
RESOURCES, TEACHING &
LEARNING APPROACHES

How can we be innovative in teaching and learning: United Nations University's experience with e-learning

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The United Nations University (UNU) has been involved with e-learning since 1996 when the Virtual University project was launched. The initial focus of this project was to build a common software platform for the sharing of teaching/learning resources. This was supported by the development of several prototype multimedia tools. The broader strategic objective of the UNU e-learning activities at this time was to assist the transformation of educational institutions in developing countries in the emerging information society.

From 2002 onwards, the work of the UNU in the area of e-learning shifted from an emphasis on technology, to content development, primarily on environmental issues. For instance, at the 2002 World Summit on Sustainable Development, UNU and United Nations Environmental Programme (UNEP) co-launched the Global Virtual University with financial support from the Government of Norway.

The primary objective of this project was to offer an online Master's degree on Development Management organized by the University of Agder (UiA) in Norway, to students in Africa. While the funding from the Norwegian Ministry of Foreign Affairs ended in 2007, the Master's programme continues with support from the NORAD Programme for Masters Studies (<http://siu.no/en/Programme-overview/NOMA>). UNU faculty members are involved in facilitating one module in the UiA Master's programme on Planning and Environmental Assessment: Theories, Methods and Techniques.

Around 25 students take the course each year, of which half are Norwegian, with the remainder from Kenya, Uganda, Tanzania, Ethiopia, Sri Lanka and Bolivia. Overseas students receive a scholarship. They spend a few weeks in Norway at the beginning of the course. Then they go back to their country, take the course online and receive support from a designated study centre at their local university. The partner universities in Africa receive a small fee to set up a study centre and supervise the students.

Another innovative educational programme that the UNU is directly involved with is the Asia Pacific Initiative (API). This was also launched in 2002 and has evolved over time to include a network of universities across the region from Honolulu to New Delhi, running semester based courses incorporating synchronous classes using video conferencing and supported via Moodle, an open source learning management system.

The classes are real time, connecting the classrooms at each participating university via video conference. The programme of lectures fits into existing courses at each university. It can be taken as an elective at undergraduate levels and for credits at graduate levels. The course is designed by the network of universities with one or two professors taking the overall coordinating role. For instance, the course on Climate, Energy and Food Security is coordinated by professors at the UNU, University of Hawaii and Keio University. Each participating university has to deliver at least one lecture.

Special guest lectures can be arranged, particularly from UN officials in the field or inspirational leaders (for example, Rajendra Pachauri, Chairman of the Intergovernment Panel on Climate Change has lectured on the course for three years in a row). The programme does not rely on external funding sources.

Each university identifies a local coordinator and ensures the courses are in line with their own university quality assurance schemes. All students who complete the course get a certificate. Approximately 160 students took the courses in fall/winter of 2008 and in the fall/winter 2009 this has increased to around 400.

When discussing how to be innovative with respect to teaching and learning, it is useful to begin with the recognition that our students have changed radically in recent years. As Marc Prensky points out they are “no longer the people our educational systems was designed to teach.”¹ Essentially, they are “digital natives” – totally comfortable with the use of digital technologies and with very different expectations about learning – and teaching and learning should be high quality, relevant, well-made, fresh, substantive and compelling for them.²

The UNU’s response to this change in the learning characteristics of today’s students has been to maximize its investment in learning resources by making them available for use in both formal and informal educational context. For instance, a video produced for the UNU webzine (societal learning), is integrated into the UNU International Course (semi-formal learning) and used as an assignment in a degree programme (formal learning).

UNU also differentiates between e-teaching and e-learning. Simply putting course materials online or uploading student assignments falls within the area of e-teaching – which is very much the traditional instructivist model where knowledge is transmitted from those who know to those who do not. To some extent, this happens in the Asia Pacific Initiative, although there is a gradual shift away from this model.

Innovative e-learning places emphasis on communication, peer interaction and tutor guidance. The focus is on supporting creative thinking, critical analysis and collaboration. To date, this has been the approach adopted for the online Master’s degree on development management mentioned above. It is based on work done by Gilly Salmon, formerly at the UK Open University, who developed a five-step approach to enhance student experience of online learning.³

The big difference is that the students on the development management course spend a few weeks together at the beginning of each year, where they are introduced to the learning management system (step 1), socialize (step 2) and learn how to exchange information, construct knowledge and develop that knowledge (steps 3 to 5). The core of this approach is the use of modules, with student assignments and clear roles for the groups, including the designation of “weavers” who pull together the main threads of the online discussions.

Over the years, the UNU has sought to mix together traditional instruction with constructivist individual learning and social constructivist collaborative learning, with mixed results. The emphasis has been on providing a blended learning experience – combining technology-based training via a learning management system with face-to-face learning opportunities. The other main challenge has been to ground the learning experience in real world situations and problems, rather than on theories and grand ideas.

But most importantly, all of UNU’s educational programmes are embedded in a cycle of continuous evaluation.

For instance, every year there are surveys among the students on the API courses about a range of issues including their overall impressions of lecture quality and the value of the course.

1 Prensky M. 2001. Digital Natives, Digital Immigrants. From *On the Horizon*. MCB University Press, Vol. 9 No. 5, October 2001. <http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf>

2 At least according to Chris Andersen author of the Long Tail: Why the Future of Business is Selling Less of More, Hyperion, 2006.

3 The model can be viewed at <http://www.atimod.com/e-moderating/5stage.shtml>

However, beginning last year, a more in-depth analysis of the student strategies related to both the use of video conferencing and the learning management system has found a diverse range of strategies from very shallow (I get information) to very deep (it is an opportunity for me to explore and learn new ideas).

Based on these evaluations, UNU has begun to modify the courses (i.e., provide more opportunity for debate in the video conferences) and look at how best to prepare the students so that they fully understand the potential of this learning environment and how to get the most out of it. Essentially, this would involve an orientation session at the start of each course to reveal to the students what the technologies are for and how the students can benefit from a reflective approach to their use. For the course designers, this means that the course materials need to be overhauled to reveal to the students successful strategies for engaging with the learning technologies.⁴

⁴ Based on research results from forthcoming paper by Ellis R, Higa C and Barrett B, Student Experiences of learning technologies in the Asia Pacific Region.

Integrating PGR related courses into a new graduate program: the case of the programme on environment diplomatic leader

KAZUO WATANABE

UNIVERSITY OF TSUKUBA, JAPAN

Global environmental issues are not only about direct natural environmental aspects but also include governances on food security, natural resources management, energy sustainability, health, development & urbanization, economy and other social matters such as ethics, etc. Therefore, it is cardinal to enforce human resource development with a multidisciplinary focus to generate capacity for environmental science and technology, principles of “environmentology” and also a common sense of cultural heritage. The education programme of Environment Diplomatic Leader (EDL) at University of Tsukuba has a curriculum responding to these necessities. It includes a 2-year Master’s programme and a 3-year PhD programme. Upon completing the programmes the trainees get the titles of Senior Environment Diplomatic Leader (PhD) and Environment Diplomatic Leader (Master’s),

The curriculum focuses especially on special lectures by top leaders, field excursions, and on-site workshops. Also, internships with international organizations and/or administration offices are encouraged.

Key persons of the programme

- Representative of the programme: Prof. Dr. Y. Iwasaki, President of University of Tsukuba.
- Head of executive committee of the programme: Assoc. Prof. Dr. M. Tsujimura, Head of Sustainable Environmental Studies, Graduate School of Life and Environmental Sciences, University of Tsukuba.
- Advisors of executive committee: Prof. Dr. I. Inoue, Assistant President, Prof. Dr. S. Kitta, Chief of International Division, Prof. Dr. K. Watanabe, Director of Foreign Students Center, and Prof. Dr. H. Uchiyama, Dean of the Head of Sustainable Environmental Studies, Graduate School of Life and Environmental Sciences, University of Tsukuba.

MSc in Biodiplomacy

The University of Tsukuba started a new interdisciplinary Master’s Programme on Biodiplomacy at the Graduate School of Life and Environmental Sciences in 2009.

This programme aims at developing human resources which can be competitive in policy, regulatory and industrial matters on biotechnology and bioresources. It emphasizes the international and interdisciplinary aspects of this topic. The inter-departmental programme, which is conducted in English, is implemented in conjunction with existing programmes like the Master’s programme in Biological Sciences & Biosystems or the Master’s programme in Agro-Bioresources, Science and Technology.

**SESSION 4. TOWARDS A
SHARED UNDERSTANDING
OF THE WAY FORWARD**

Group work on internal and external drivers and influences

Working in two groups, the participants addressed the questions:

- How do internal and external drivers influence PGR education?
- What innovations and new opportunities for teaching and learning could strengthen PGR education?

Internal and external drivers influencing PGR education

Most universities have much to offer in terms of human resources with strengths in conservation, molecular methods and bio-informatics. However, PGR education is plagued by many internal problems: low student intake, lack of programme continuity, more focus on conservation than use, lack of quality research, limited scholarships and high costs of running laboratories and genebanks.

Further, political instability, lack of opportunities (funding and job-wise) and the declining popularity of agriculture are among the negative external factors that influence PGR education.

On a positive note, agrobiodiversity issues are becoming more mainstream. There is now good potential for media, government and funding agencies to pay more attention to the topic.

Innovations and new opportunities for teaching and learning

PGR training for professionals.

Universities can attract professionals to their PGR programme by offering short, multi-disciplinary courses via web-based platforms.

PGR training at large.

Rebranding of PGR courses are best done by integrating them in more popular field of study such as Biotechnology, and Environmental Sciences. More stress on outputs and experience as well as conducting industry-related research can open doors to more funding sources.

PGR as a self-contained programme.

PGR has to branch out to a broader range of thematic areas, such as diplomacy, law, environmental accounting, economics and entrepreneurship studies, to open up more career opportunities. It may also be worth looking at having 1-year MSc PGR programmes by course work instead of 2-year research-based programmes.

PGR-Public Relations.

Media, civic social organizations (NGOs, INGOs, POs) and secondary schools can act as conduits in delivering PGR-related messages.

International collaborations.

Climate change, adaptation of crops to new environment, and underutilized crops are topics that offer a basis for international collaboration.

Innovations.

Ready-made self-learning modules on PGR using new platforms such as e-teaching and e-learning must be explored.

Recommendations.

- Short course on “Agrobiodiversity for Climate Change” for policy managers
- Short course on “Health, Nutrition and Agrobiodiversity”
- Career enhancement for government officials

Comments on the group discussions at open forum

Can PGR play a role in the revival of agricultural education? It is possible, suggested the participants. But critical issues must first be addressed by changing the name of programme, connecting PGR with environmental issues, linking with international institutions to give credibility, and piggy-backing on bio-technology and genomics.

Undeniably, there is a need to widen the reach of PGR education. For instance, in remote countries (Lao PDR and Myanmar), PGR awareness is very low. The regional PGR networks are also focused mostly only on conservation and research rather than use.

But there are clear opportunities to tap. In Malaysia, for example, there is a strong opportunity for mainstreaming PGR issues into Malaysia’s 5-year plan.

Strategies for curriculum change

The second group work focused on strategies for curriculum change. Again working in two groups, participants discussed two key strategies that universities could use:

a. Enhancing general agricultural courses and programmes in PGR-related areas of learning

PGR and agrobiodiversity need more visibility in agriculture programmes. This can be achieved by:

- including a specific course on PGR in the general agriculture curriculum
- incorporate ecology, and evolution into courses
- aligning PGR with current issues such as climate change, food security, and biofuels
- teaching PGR issues in quantitative genetics, and population genetics, rather than only in plant breeding courses.

It is also recommended that each institute has its own genebank

2010 has been declared UN year of biodiversity. Bioversity International should raise awareness among institutes in the region of the importance of PGR education to through media channels such as TV spots and YouTube clips.

b. Enhancing MSc PGR programmes: Abolish? Status quo? Change/modify?

Despite its weaknesses, participants believe in maintaining the original objective of PGR education – to provide expertise on conservation and management. But the content must be enhanced and harmonized to include introductory courses across universities, such as: bioinformatics, genomics, natural products, enhancement, law and policy and valuation. A change in name would also help attracting more students. Some suggestions include: MS in Biodiversity Studies or MS in Bioresources Sciences.

Independent surveys must also be conducted to determine the needs of industry and civil society.

External assistance would contribute to enhancing programmes and increasing their attraction. For example, UKM requires assistance in terms of scholarships, and funds for capacity building and public relations. Meanwhile, UPLB needs assistance to redesign the courses and to obtain leveraging funds.

Plenary discussion: Putting the plans into action

In the final plenary session, the workshop participants developed an action plan on enhancing PGR education in East and Southeast Asia and Oceania (Table 12). First, a brainstorming session gathered ideas for how this could be achieved. Participants then set priorities within each category: Course enhancement; Degree enhancement; Short courses; Networking, and; Awareness. For each action item, and implementation mechanism, including responsibilities and a timeframe was also agreed upon.

There was consensus that the most urgent action points are to:

- Incorporate PGR content in relevant courses, such as quantitative genetics, population genetics and others
- Create scholarships for Masters' degrees for international students
- Work with universities' leadership to influence existing opportunities for PGR
- Broaden the scope to include: bioinformatics, biotechnology, genetic enhancement, genomics, gene discovery, natural products, valuation, law and policy including bio-diplomacy, etc.

Other critical action areas are to:

- Conduct surveys with stakeholders to determine needs for PGR competence
- Continue the networking on PGR education in the APO region
- Develop short courses/workshop for policy makers, young professionals who have not been exposed to PGR

The full action plan on enhancing PGR education in the region is shown in Table 12.

Table 12. Action plan on enhancing PGR education in East and Southeast Asia and Oceania.

Issue/concern	Action	Priority votes	Responsibility
1. Course enhancement			
PGR and agrobiodiversity are not mentioned in course titles and lack visibility.	<ul style="list-style-type: none"> Incorporate PGR content in relevant courses, such as quantitative genetics, population genetics 	3	All relevant universities
Undergraduate students are unaware of PGR topics	<ul style="list-style-type: none"> Include aspects of PGR in 1st year undergraduate courses to create exposure and raise interest 	1	All relevant universities
PGR- related courses are unattractive to environmentally-oriented students	<ul style="list-style-type: none"> Change names of courses to make them more attractive 	-	All relevant universities
2. Degree enhancement			
Enrolment in Masters' degree programmes is linked to scholarship opportunities, but these are difficult to find.	<ul style="list-style-type: none"> Create scholarships for Masters' degrees for international students Work with University leadership and regional organizations to direct existing scholarship opportunities towards PGR (e.g. SEARCA, PCCARD) 	5	SEARCA affiliated universities and institutions; Bioversity
The PGR programmes are perceived as narrow, and a range of important areas of relevance to PGR are currently not covered in curricula	<ul style="list-style-type: none"> Broaden the scope to include: bioinformatics, biotechnology, genetic enhancement, genomics, gene discovery, natural products, valuation, law and policy including bio-diplomacy, etc. 	5	UPLB, UKM
Some universities, especially those with 1-year MSc programmes are relatively weak in research	<ul style="list-style-type: none"> Improve quality of research in MSc programmes by increasing research time/ credit hours 	3	UKM
PGR- related courses seem not to be attractive to environmentally-oriented students	<ul style="list-style-type: none"> Change of names of degree programmes to make them more attractive; e.g., bio-resources sciences; or biodiversity studies 	3	UPLB, UKM
Unclear job market for PGR graduates	<ul style="list-style-type: none"> Conduct surveys with stakeholders to determine needs for PGR competence 	3	Bioversity & universities

continued/ Table 12. Action plan on enhancing PGR education in East and Southeast Asia and Oceania.

Issue/concern	Action	Priority votes	Responsibility
PGR-related research is often done in isolation and opportunities for public-private partnerships are not fully tapped.	<ul style="list-style-type: none"> • Industry-related research • Collaborative research 	2	All concerned
Currently there is emphasis on government jobs. A paradigm shift needed to open up for 'PGR entrepreneurship'.	<ul style="list-style-type: none"> • Introduce courses on entrepreneurship • Demonstrate the potential of PGR for wealth creation 	2	Concerned universities
Using innovative learning approaches can attract more students	<ul style="list-style-type: none"> • Enhance degree programmes through eLearning on PGR 	1	Universities, and relevant organizations
Universities lack staff in some key 'frontline' areas of PGR conservation and use	<ul style="list-style-type: none"> • Use expertise from PGR- relevant institutions as guest lectures 	1	Bioversity in collaboration with universities
Students are not getting sufficient practical experience	<ul style="list-style-type: none"> • Increase the component of site visits and field studies 	-	Concerned universities
A 2-year MSc programme with a research component may not be attractive	<ul style="list-style-type: none"> • Explore the option of a non-thesis programme for increased enrollment 	-	Concerned universities
<p><u>3. Short courses</u></p> <p>Many working professionals would benefit from better knowledge of PGR issues. Short courses can provide competence.</p>	<ul style="list-style-type: none"> • Develop short courses/workshop for policy makers, young professionals who have not been exposed to PGR. <p>Guide course titles:</p> <ul style="list-style-type: none"> • Agrobiodiversity for climate change, for awareness raising for policy makers (3-5 days) • Agrobiodiversity, human health and nutrition • Agrobiodiversity and food security • Agrobiodiversity and environmental ethics • Agrobiodiversity and trade • Agrobiodiversity, biotechnology and genomics • Agrobiodiversity and urbanization 	3	Concerned universities, with Bioversity, UNU

continued/ Table 12. Action plan on enhancing PGR education in East and Southeast Asia and Oceania.

Issue/concern	Action	Priority votes	Responsibility
<p>4. Networking</p> <p>Universities' teaching of PGR courses and programmes could become more effective if they strengthen their collaboration</p> <p>Insufficient exchange of knowledge and information on PGR education</p> <p>Opportunities for joint offering of courses, and for training working professionals are not sufficiently captured</p> <p>Outdated and too narrow curricula</p> <p>Insufficient knowledge sharing between PGR networks in Asia Pacific and universities</p>	<ul style="list-style-type: none"> • Continue the networking on PGR education in the APO region. (A network name: Biodiversity Education Asia Network (BEAN) was mentioned) • Create a network website (see the example from Tsukuba) • Develop and support eLearning • Collaboration to facilitate curriculum development and review • Link educational networks with PGR networks 	<p>5</p> <p>2</p> <p>2</p> <p>2</p> <p>1</p>	<p>Tsukuba University, to take a lead to organize the network</p> <p>Tsukuba University in collaboration with Bioversity</p> <p>UNU & Tsukuba to play a role</p> <p>Bioversity, All concerned universities</p> <p>Bioversity</p>
<p>5. Awareness</p> <p>Insufficient awareness of PGR education opportunities</p>	<ul style="list-style-type: none"> • Promote relevant courses to attract prospective students, e.g. via: Bioversity Website, Newsletters; SEARCA website; YouTube, Facebook; FAO/GIPB; TV and media; Poster exhibits and brochure on PGR to attract students; Road show; Briefs on PGR 	<p>1</p>	<p>All concerned universities</p>

Closing session

The action plan was presented in the workshop's closing session, and was endorsed by all participants.

Dr Leocadio Sebastian, on behalf of Bioversity International and all participants, thanked Prof. Kazuo Watanabe and his staff at University of Tsukuba's Gene Research Center for the excellent organization and hosting of the workshop. He also recognized the generous financial support from the Japanese sponsors, which enabled the participation of universities from the region.

Visit to National Institute of Agrobiological Science (NIAS) genebank

After the workshop's closing session, the participants had the opportunity to visit the National Institute of Agrobiological Sciences (NIAS) Genebank. The Genebank Director, Dr Makoto Kawase guided a tour of the NIAS genebank facilities, including its cryo-preservation laboratory. He demonstrated the processes and workflow of genebank management and its information system.






NIAS Genebank Director Dr Makoto Kawase demonstrating the cryopreservation facilities at the NIAS Genebank (Top photo by Per Rudebjer; bottom photo by Leocadio Sebastian).

Workshop photos



(All photos on this page were taken by Leocadio Sebastian)

Annex 1. Programme

DAY 1 –17 NOVEMBER, 2009	
830	<p>OPENING SESSION</p> <ul style="list-style-type: none"> WELCOME ADDRESS FROM TSUKUBA UNIVERSITY – PROF. KAZUO WATANABE WELCOME ADDRESS FROM BIOVERSITY INTERNATIONAL – DR. LEOCADIO SEBASTIAN ROUND THE TABLE INTRODUCTION OVERVIEW OF WORKSHOP OBJECTIVES, EXPECTED OUTPUTS AND PROGRAMME – MR. PER RUDEBJER, BIOVERSITY INTERNATIONAL GLOBAL INITIATIVES ON AGROBIODIVERSITY EDUCATION – A BRIEF UPDATE- MR. PER RUDEBJER
930	<p>SESSION 1. REVIEW OF UNIVERSITIES’ EXPERIENCES FROM TEACHING PLANT GENETIC RESOURCES COURSES AND PROGRAMMES</p> <p><u>TEACHING PGR-RELATED COURSES: EXPERIENCES FROM PAST FIVE YEARS:</u></p> <ul style="list-style-type: none"> EXPERIENCES FROM UNIVERSITY PUTRA MALAYSIA (UPM) - PROF. GHIZAN BIN SALEH EXPERIENCES FROM UNIVERSITY OF MALAYSIA (UM) - PROF. HALIJAH BINTI IBRAHIM
1000	 + Group Photo
1030	<ul style="list-style-type: none"> EXPERIENCES FROM KASSETSART UNIVERSITY, THAILAND - MR. HUGO VOLKAERT AND DR. SIRIKUL WASEE EXPERIENCES FROM THE UNIVERSITY OF NOTTINGHAM - DR. PETER G ALDERSON EXPERIENCES FROM KANGWON NATIONAL UNIVERSITY, KOREA - DR. NAM SOO KIM PGR COURSES AND CURRICULA IN THE PACIFIC - MR. TEVITA KETE AND DR. MARY TAYLOR
1115	<p><u>TEACHING MSC PROGRAMMES ON PLANT GENETIC RESOURCES: EXPERIENCES FROM PAST FIVE YEARS:</u></p> <ul style="list-style-type: none"> EXPERIENCES FROM UNIVERSITY OF THE PHILIPPINES LOS BAÑOS (UPLB) - PROF. TERESITA BORROMEO EXPERIENCES FROM UNIVERSITY KEBANGSAAN MALAYSIA (UKM) - PROF. MOHAMAD BIN OSMAN
12.00 - 13.30	
1330	<ul style="list-style-type: none"> GROUP DISCUSSION TO CAPTURE NEW INSIGHTS AND ESSENTIAL POINTS FROM SESSION 1
1400	<p>SESSION 2. VIEWS AND FEEDBACK FROM PGR STAKEHOLDERS: EMPLOYERS AND STUDENTS</p> <ul style="list-style-type: none"> WHAT COMPETENCIES DO PRIVATE SEED COMPANIES SEEK IN GRADUATES SPECIALIZING IN PGR – PROF. KAZUO WATANABE EXPERIENCES ON PGR TRAINING FROM THE PERSPECTIVE OF GENE BANK MANAGEMENT - DR. MASARU TAKEYA
14.40 - 15.00	
1500	<ul style="list-style-type: none"> FEEDBACK FROM STUDENTS: OUTCOME OF FOCUSED GROUP DISCUSSION IN THE PHILIPPINES - PROF. NESTOR ALTOVEROS FEEDBACK FROM STUDENTS: OUTCOME OF FOCUSED GROUP DISCUSSION IN MALAYSIA - PROF. MOHAMAD BIN OSMAN
1600	<ul style="list-style-type: none"> GROUP DISCUSSION TO CAPTURE NEW INSIGHTS AND ESSENTIAL POINTS FROM SESSION 2
1730	<p>WELCOME DINNER HOSTED BY TSUKUBA UNIVERSITY</p>

DAY 2 –18 NOVEMBER, 2009	
830	CHECK-IN AND REFLECTION ON DAY 1 - PARTICIPANTS
845	<p>SESSION 3. REGIONAL AND INTERNATIONAL OUTLOOK REGARDING CONSERVATION AND USE OF PLANT GENETIC RESOURCES, AND TEACHING AND LEARNING APPROACHES</p> <p><u>INTERNATIONAL PERSPECTIVES ON RESEARCH AND POLICY</u></p> <ul style="list-style-type: none"> ENVIRONMENTAL CHALLENGES WITH LOCAL STAKEHOLDERS: 3 E FORUM AT TSUKUBA- PROF. KAZUO WATANABE, UNIVERSITY OF TSUKUBA LAW AND POLICY ON PLANT GENETIC RESOURCES - PROF. NESTOR ALTOVEROS OPEN FORUM ON KEY ISSUES
1000	
1020	<p><u>RECENT DEVELOPMENTS IN AGROBIODIVERSITY EDUCATION</u></p> <ul style="list-style-type: none"> HOW CAN WE BE INNOVATIVE IN TEACHING AND LEARNING? - DR. BRENDAN BARRETT, MEDIA STUDIO, UNITED NATIONS INTEGRATING PGR RELATED COURSES INTO A NEW GRADUATE PROGRAM: THE CASE OF THE PROGRAMME ON ENVIRONMENT DIPLOMATIC LEADER - PROF. KAZUO WATANABU
1120	<ul style="list-style-type: none"> GROUP DISCUSSION TO CAPTURE ESSENTIAL POINTS FROM SESSION 3
12.00 13.30	
1330	<p>WORKSHOP: INTERNAL AND EXTERNAL DRIVERS AND INFLUENCES THAT UNIVERSITIES NEED TO ADDRESS</p> <p>THEMES TO BE EXPLORED IN GROUPS AND PLENARY (WORKING IN TWO GROUPS)</p> <ul style="list-style-type: none"> INTERNAL AND EXTERNAL DRIVERS INFLUENCING PLANT GENETIC RESOURCES AND AGROBIODIVERSITY EDUCATION INNOVATIONS AND NEW OPPORTUNITIES FOR TEACHING AND LEARNING
14.50 15.10	
1510	<p>SESSION 4. TOWARDS A SHARED UNDERSTANDING OF THE WAY FORWARD</p> <p>WORKSHOP: STRATEGIES FOR CURRICULUM CHANGE. GROUP EXERCISE ON:</p> <ul style="list-style-type: none"> ENHANCING GENERAL AGRICULTURAL COURSES AND PROGRAMMES IN PGR-RELATED AREAS OF LEARNING ENHANCING MSC PGR PROGRAMMES
DAY 3 –19 NOVEMBER, 2009	
830	CHECK-IN AND REFLECTION ON DAY 2 - PARTICIPANTS
845	<ul style="list-style-type: none"> PRESENTATION ON STRATEGIES FOR CURRICULUM CHANGE
1000	
1020	<p>WORKSHOP: PUTTING THE PLANS INTO ACTION</p> <ul style="list-style-type: none"> ACTION PLAN
12.00 13.30	
1330	<p>CLOSING SESSION</p> <ul style="list-style-type: none"> PRESENTATION OF ACTION PLAN AND IMPLEMENTATION MECHANISM CLOSING
14.00 17.00	– VISIT TO NATIONAL INSTITUTE OF AGROBIOLOGICAL SCIENCE (NIAS) GENE BANK

Annex 2. List of Participants

Reviewing Plant Genetic Resources
Education in East and Southeast Asia
17-19 November 2009, University of Tsukuba, Japan

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Participants of the international workshop on 'Reviewing Plant Genetic Resources Education in East and Southeast Asia' held on 17-19 November 2009 at the University of Tsukuba in Japan.



University of Tsukuba