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Conservation and Utilization of Crop Genetic Resources in Malaysia: Mardi's Effort

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Abstract: Malaysian Agriculture Research and Development Institute (MARDI) is the country's major custodian of the nation's crops genetic resources. It has a global responsibility in the conservation of genetic resources of banana, sweet potato and citrus, and national responsibility for the conservation of crops, such as rice, tropical fruits and some herbs and medicinal plant species. MARDI rice seed genebank at Seberang Prai in the state of Penang was established in 1984 and currently holds 12,770 registered rice accessions, of which 53% are of local origin. In addition, MARDI also conserves genes in the field, mostly for underutilized tropical fruit genetic resources. At present, about 168 species of underutilized, rare and wild tropical fruit species consisting of about 2,000 accessions, the largest in the country, are being conserved. The species include "kuini" (*Mangifera odorata*), "bacang" (*Mangifera foetida*), "binjai" (*Mangifera caesia*), "cerapu" (*Garcinia praniana*), "rambai" (*Baccaurea motleyana*), "asam gelugor" (*Garcinia atroviridis*), "terap" (*Arthocarpus odoratissimus*) and "pulasan" (*Nephellium rambutan-ake*). The accessions are mostly conserved *ex situ* in field genebanks located at the various MARDI stations throughout the country. Although the conservation of the various crop species genetic resources is important, the real challenge is enhancing its utilisation. The main objective of the paper was to share and disseminate information related to works conducted and strategies opted by MARDI on the conservation and utilization of crop genetic resources. Information on species of crops that are available in MARDI's genebank was also highlighted together with brief information of some of the associated traits of significant importance posses by those genetic resources.

Key words: Conservation, genetic resources, tropical fruits, germplasm, genebanks.

1. Introduction

Among the many species of vegetables, fruits, herbs, medicinal plants and other organisms of the world currently described, a significant number of them, such as rice, banana, sweet potato and citrus, is originated and domesticated in Malaysia [1-3]. Some of those species have shown some level of adaptation to abiotic and biotic stresses prevailing locally [2]. The conservation of these various crop genetic resources will serve as a valuable source of genetic materials for future germplasm enhancement. However, these genetic resources are slowly eroding through the degradation of their natural habitats, intensification of the cultivation and expansion of cultivation into marginal areas (even some into areas currently occupied by the genebank itself).

Malaysian Agriculture Research and Development Institute (MARDI) is the country's major custodian of the nation's crops genetic resources, and has both global and national crop mandates under its wings. It has a global responsibility in conservation of banana, sweet potato and citrus, and national responsibility for conservation of crops, such as rice, tropical fruits and some herbs and medicinal plant species [4]. The *ex situ* collections developed and maintained by MARDI allow continuous and reliable access to important plant genetic resources related to food and agriculture (PGRFA) required to develop improved varieties. However, the job of managing these genes or genetic

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resources of those crops has never been easy.

Currently, MARDI is conducting research on "on-farm conservation" of indigenous tropical fruit genetic resources to search for appropriate technologies, which can maintain the naturally occurring and evolving populations of those species within their growing environment. Innovative approaches to *in situ* conservation are needed, such as this that not only conserve but also enhance the productive capacity and economic livelihoods of the communities involved. The approach if successful will take into account the social, economic and environmental constraints in land use planning and practices. Preliminary findings so far showed that incentive or compensatory policy measures still needs to be developed to support and encourage the adoption of measures for the conservation, management and sustainable use of crop genetic resources on-farm [5].

The main objective of the paper was to share and disseminate information on works conducted by MARDI related to the conservation and utilization of crop genetic resources. Highlighted in the paper was the various strategies opted by the institute to ensure that crop genetic resources would continue to be conserved and utilized sustainably.

2. Crops Genebank in MARDI

Malaysia is rich in biological diversity, harbouring some 185,000 species of flora and more than 15,000 species of flowering plants. Among them are over 2,500 tree species, 3,000 species of orchids, 500 species of ferns, and 60 species of grasses and bamboos [6]. However, only a few have been utilized for food production. It has been reported that only about 300 fruit species native to the country have been exploited and utilized [7]. The remaining is still growing wild or semi-wild, and their economic potential has not been investigated in greater detail. Because of these richness, Malaysia is recognized as one of 12 mega diversity countries of the world. It is estimated to house more than 3.5 million of crop genes contributed by close to 1,000 species of crops cultivated and its various wild relatives [7].

However, Malaysia is slowly losing this vitally important diversity. As farmers change the crops they grow to meet new needs or take advantage of new opportunities, they often abandon the old traditional highly diverse varieties. And as varieties are discarded, traits they contained are lost, but could prove to be valuable in the future. Beyond farmers' fields, as land is cleared or becomes degraded, the wild relatives also face extinction. And, through lack of reliable funding, diversity is also being lost in the very genebanks itself which have been built for crop genetic resource conservation. As the consequences, Malaysia is progressively losing the foundations, upon which the nation agriculture is built. It is imperative that every effort should be made to safeguard and conserve what is arguably humanity's most valuable resource.

MARDI has long recognized the importance of crop genetic resources and the genes in addressing food insecurity issues, climate change related problems and wealth creation. Its seed genebank located in the Northern part of the country was established way back as early as in the 70s [8]. In fact, conservation effort was started as early as in 1950's by the Department of Agriculture. It was continued by MARDI in 1971 with the addition of some research work on the utilization of the genetic resources in rice improvement. In late 1989, MARDI and Bioversity International (formerly known as International Plant Genetic Resources Institute (IPGRI)) jointly financed to build a rice genebank facility. The facility was built in the compound of MARDI research station, Seberang Perai, in the state of Penang. The genebank was mandated to: (1) collect local and foreign genetic resources of the genus *Oryza*; (2) systematically characterise and evaluate the conserved germplasms; (3) conserve the accessions under ideal storage conditions; (4) establish a databank information system; (5) conduct research in conservation technology; (6) disseminate seed and information for use in research. The

genebank currently holds 12,770 registered accessions, of which 53% are of local origin. The remainders are accessions introduced from 27 different rice growing countries as well as accessions received from International Rice Research Institute (IRRI) in the Phillipines [8].

In addition to seed genebank, MARDI also conserves genes in the field, mostly for underutilized fruit genetic resources [9]. At present, about 150 species of underutilized, rare and wild fruit species consisting of about 2,000 accessions, the largest in the country, are being conserved at MARDI. The species include "kuini" (*Mangifera odorata*), "bacang" (*Mangifera foetida*), "binjai" (*Mangifera caesia*), "cerapu" (*Garcinia praniana*), "rambai" (*Baccaurea motleyana*), "asam gelugor" (*Garcinia atroviridis*), "terap" (*Arthocarpus odoratissimus*) and "pulasan" (*Nephellium rambutan-ake*). The accessions are mostly conserved *ex situ* in field genebanks located at the various MARDI stations throughout the country.

Although the conservation of the underutilized fruit species genetic resources is important, the real challenge is enhancing its utilization. To be meaningful, the collected materials have to be grown, carefully described, evaluated and documented. In the past, many of those genetic resources and accessions have not been well characterised and evaluated. The accessions were of no use for the breeders, if they are not evaluated. Thus, in the last few years, research related to genetic resources of underutilized fruit species at MARDI was focused on how to enhance utilization of those underutilized genetic resources. Characterisation and evaluation for important traits useful to breeders, its nutraceutical and pharmaceutical properties, and identification of germplasm of potential for direct use by farmers have been intensified. Intensive collection and rigorous characterisation and evaluation of those accessions for fruit size, texture, taste and aroma have resulted in the identification of elite accessions for commercialization. To date, MARDI had identified and introduced elite accessions of at least seven underutilized fruit species. These elite accessions include two accessions each for "kuini" (*Mangifera odorata*), "bacang" (*Mangifera foetida*), "binjai" (*Mangifera caesia*) and "pulasan" (*Nephelium ramboutan-ake*), and one accession each for "tampoi' (*Baccaurea macrocarpa*), "kundang" (*Bouea macrophylla*) and "durian kuning" (*Durio graveolens*).

Underutilized fruit species contribute to the food security as a source of nutrition as well as secure household income. Information on their nutritional values is therefore important in promoting these fruits as a source of nutrition. Research on the nutritional analysis of underutilized fruit accessions in the genebank started quite recently. They were analysed for their proximate values, vitamins, minerals and antioxidants. The data obtained so far showed that *Sandoricum koetchapi* ("sentol"), *Mangifera foetida* ("bacang"), *Mangifera caesia* ("binjai") and *Durio kutejensis* ("nyekak") have high vitamin C (> 30 mg/100 g of fresh weight), while "bacang" (*Mangifera foetida*), "durian isu" (*Durio oxleyanus*) and "durian nyekak" have high potassium (> 300 ppm). Other underutilized fruits, such as "ceri terengganu", "rukam", "kuini", "bacang", "bambangan", "asam kelubi" and "bidara", have high antioxidant capacity (> 70%) [7, 10].

3. MARDI Future Strategies in Genebank

3.1 On-Farm Conservation

The strategy for the future is to promote on-farm conservation of underutilized fruit genetic resource. A study conducted by MARDI has shown that some home gardens and orchards in Peninsular Malaysia as well as in Sabah and Sarawak have high distribution and diversity of underutilized fruit species. Areas with high fruit diversity were verified using participatory rural appraisal (PRA) technique. The district which had the highest species richness in Peninsular Malaysia was Kuala Lipis (S = 69) in Pahang, while in Sarawak was Sibuti (S = 60) and in Sabah was Kota

Belud (S = 49) [11].

In collaboration with Bioversity International, a UNEP/GEF funded project was carried out, aiming at understanding factors that contribute to the successful maintenance of diversity on-farms [5]. The project also aimed at identifying the tools that would enable this diversity and the processes be maintained, assessed, and to understand the complementarities between *in situ*/on-farm and *ex situ* conservation. Once completed, the project is expected to provide information on how to achieve the best balance in the use of these two conservation approaches and the dynamic nature of its relationship. The project is also expected to provide information on the farmers' management processes and practices that have maintained this diversity, the national capacity to support the maintenance of those diversity and the appropriate interventions needed from the policy makers. The project covers six locations in Sabah, Sarawak and Peninsular Malaysia. The study measures the diversity of fruit species of three genera *Mangifera*, *Nephelium* and *Garcinia* in the home gardens and also *in situ*. Previous studies showed that considerable *Mangifera*, *Nephelium* and *Garcinia* species diversity exists within and among home gardens studied. However, some interventions may be needed to make these fruit species more competitive with modern fruits and other major crops. Potential interventions to increase competitiveness may include promoting the increased consumer demand, the enhanced linkage to market and more supportive policies and incentives. Raising public awareness of local crops and varieties can help build a broader base of support. In this study, this will be achieved through personal contacts, group exchanges, diversity fairs and the establishment of markets and fairs for the promotion of local products. Other ways may include branding products with internationally accepted certificates of origin or the like for niche markets, and developing commercial value-added, "diversity-rich" products.

3.2 Enhancing Research and Use of Cryopreservation Technique in Conservation of Recalcitrant Seeds

In vitro conservation, such as cryopreservation, could be the solution for the conservation of most of Malaysian recalcitrant underutilized fruit genetic resources. At present, seeds of those genetic resources are very difficult to store or is stored with limited success. Among the species with recalcitrant seeds which Malaysian scientist is currently working, are "mangosteen" (*Garcinia mangostana*), "langsat" (*Lansium domesticum*) and "rambai" (*Baccaurea motleyana*). To date, there are still no successful standard techniques or protocols for species with highly recalcitrant seeds, such as *Garcinia* species. Modification of existing protocols or development of new methods is required, but this can be accomplished only when a detailed understanding of the recalcitrant nature of the seeds or explants is achieved. While Malaysian researchers have considerable knowledge concerning the basics of biochemical processes and some molecular data from work on desiccation-tolerant seeds, a great need remains for understanding the cause of the recalcitrance or desiccation sensitivity of these seeds [12].

3.3 Enhance Sustainable Utilization of the Plant Genetic Resource for Food and Agriculture in the Country

At national level, optimum but sustainable utilization of PGRFA will continue to be emphasized with benefits shared with farmers and local communities [13]. More involvement of local communities in the conservation, especially on-farm, will be enhanced. With the national law in place, Malaysia will ensure fair distribution to the nation and local communities of benefits arising from the use of PGRFA.

3.4 Develop a Centre of Excellence in PGRFA

Malaysia is at the final stage of establishment of the national crop genebank with higher capacity, facilities

and resources. This genebank will be the "one stop centre" and coordinator of any germplasms exchange in the country. Malaysia has already established national biodiversity centre under Ministry of Natural Resources and Environment (NRE), of which PGRFA is under the responsibility of Ministry of Agriculture with MARDI as the implementing agency.

3.5 Strengthen the Institutional Framework for PGRFA Management

Malaysia will set up a high level policy formulation, coordination and advisory body with effective representation from all relevant federal ministries, agencies and state governments. Through the steering committee of the national genebank, Ministry of Agriculture will coordinate across ministries on all PGRFA activities in the country. With the establishment of the national biodiversity centre, task of coordination of programmes, implementation, monitoring, evaluation, priority setting and information management has become more systematic and effective with the participation of the private sector and non-governmental organizations.

3.6 Strengthen and Integrate Conservation Programmes on PGRFA

Efforts to strengthen and integrate conservation of PGRFA in Malaysia will be further enhanced in the 11th Malaysian plan (2016-2020). *Ex situ* and on-farm conservation sites or centres to cater for threatened species, for breeding and selection and as repositories for germplasm, i.e., genebanks, botanical gardens and arboreta, will be expanded. It is suggested to gazette certain areas for this purpose. Public involvement will continue to be ensured in planning and management of protected areas, taking into consideration the involvement of local communities. Mechanism for ensuring compatibility between conservation and sustainable development will be developed, and research to determine minimum viable population sizes for species and critical minimum size of conservation areas will be intensified.

4. Conclusions

Crop genetic resources have long been recognized as the most valuable part of biodiversity. It is critical for food security, and its rare and wild species of food crops can be utilized as sources of new industrial crops. MARDI has long recognized the importance of crop genetic resources and the genes in addressing food insecurity issues, climate change related problems and wealth creation. More than 300 tropical fruit species are available in Malaysia. Through several efforts made by MARDI, some of the fruit species, such as *Durio* spp., *Mangifera* spp., *Nephelium* spp. and several others have been conserved in the field genebank of MARDI. Some of them have been shown to have commercial importance and released as new crop. As for the future, MARDI will conduct more works on the sustainable utilization of the resources currently conserved to realize its full potential.

References

[1] Salma, I., Masrom, H., and Yahya, I. 2000. "A Survey of Edible Fruit Species in Belum Forest Reserve, Perak, Peninsular Malaysia." *Malayan Nature J.* 54 (3): 223-6.

[2] Abdullah, M. Z., Vaughn, D. A., and Mohamad, O. 1991. *Wild Relatives of Rice in Malaysia: Their Characteristics, Distribution, Ecology and Potential in Rice Breeding.* Malaysian Agriculture Research and Development Institute (MARDI) Report No. 145.

[3] Jong, K., Stone, B. C., and Soepadno, E. 1973. "Malaysian Tropical Forest: An Underexploited Genetic Reservoir of Edible Fruit Species." In *Proceedings of the Symposium on Biological Resource and Nature Development*, 113-21.

[4] Sharif, H., and Jamadon, B. 2008. "Advancing Agrobiodiversity Conservation and Utilization in MARDI." In *Agrobiodiversity in Malaysia*, edited by Mohd-Shukor, N., Salma, I., and Mohd-Said, S. Serdang, Selangor: Malaysian Agriculture Research and Development Institute (MARDI).

[5] Raziah, M. L., Khadijah, A., Abd-Rahman, M., Wong, W. W., Salma, I., Lau, C. Y., and Azuan, A. 2011. "Contribution of Home Gardens and Orchards to On-Farm Conservation of Underutilized Fruit Species."

In *Agrobiodiversity in Malaysia II: Conservation and Sustainable Utilization*, edited by Nordin, M. S., Idris, S., Yusof, M. R. M., and Ali, M. S. M. Kuala Lumpur: Malaysian Agriculture Research and Development Institute.

[6] Ministry of Science Technology and Innovation (MOSTI). 1997. *Assessment of Biological Diversity in Malaysia.* Kuala Lumpur: MOSTI.

[7] Mohd Shukor, N., Rosliza, J., Zulhairil, A., Wan Darman, W. A., and Mohamad Ghadafi, D. 2010. *Conservation and Utilization of Plant Genetic Resources for Food and Agriculture in Malaysia.* Serdang, Selangor: Malaysian Agriculture Research and Development Institute.

[8] Abdullah, M. Z. 2003. "Handling of Rice Seed for Germplasm Conservation and Use." In *Proceedings of the 3rd National Seed Symposium: Prospects and Opportunities*, 104-8.

[9] Salma, I. 2006. *Conservation of Tropical Fruit Tree Genetic Resources in Malaysia.* LOA No. APO/05/11, Consultant Report to IPGRI, Rome.

[10] Mirfat, A. H. S., Salma, I., and Razali, M. 2011. "Underutilised Indigenous Fruit Species with Promising Antioxidants." In *Agrobiodiversity in Malaysia II: Conservation and Sustainable Utilization*, edited by Nordin, M. S., Idris, S., Yusof, M. R. M., and Ali, M. S. M. Kuala Lumpur: Malaysian Agriculture Research and Development Institute.

[11] Salma, I., Mohd-Nor, A., Masrom, H., and Raziah, M. L. 2006. "Diversity and Use of Traditional Fruit Species in Selected Home Gardens of Fruit Orchards in Malaysia." *J. Trop. Agric. and Food Sci.* 34 (1): 149-64.

[12] Normah, M. N. 2011. "Achievements in Cryopreservation of Tropical Crops in Malaysia." In *Agrobiodiversity in Malaysia II: Conservation and Sustainable Utilization*, edited by Nordin, M. S., Idris, S., Yusof, M. R. M., and Ali, M. S. M. Kuala Lumpur: Malaysian Agriculture Research and Development Institute.

[13] Malaysian Agriculture Research and Development Institute (MARDI). 2010. "National Strategies and Action Plans on Agricultural Biodiversity Conservation and Sustainable Utilization." MARDI, Serdang, Selangor, Malaysia. Accessed October 2013. http://www.fao.org/ag/againfo/programmes/documents/genetics/country_reports/Malaysia_NSAP_Oct2013.pdf.