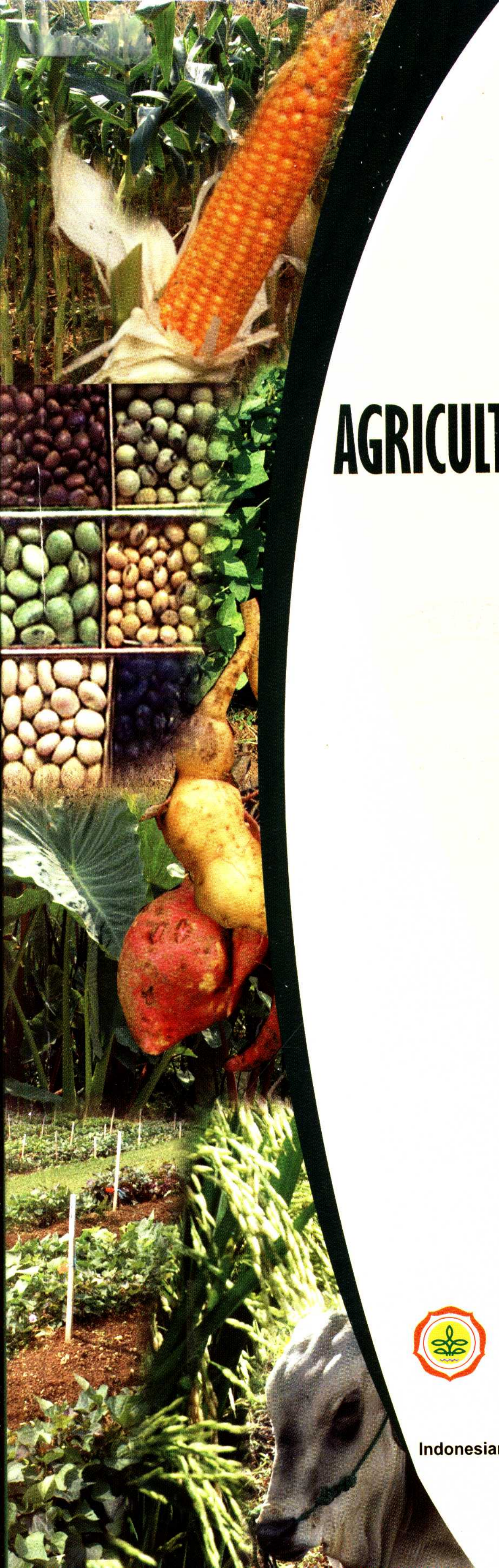
ISBN : 978-979-3919-08-9



MANAGING AGRICULTURAL GENETIC RESOURCES IN INDONESIA

Ministry of Agriculture
Indonesian Agency for Agricultural Research and Development
Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD)

MANAGING
AGRICULTURAL GENETIC RESOURCES
IN INDONESIA

Edited by S. Moeljopawiro, M. Thohari, and M. Herman

Indonesian Center for Agricultural Biotechnology and Genetic Resources
Research and Development (ICABIOGRAD)
Indonesian Agency for Agricultural Research and Development
Ministry of Agriculture

Printed in 2012

Catalogue in publication

Managing Agricultural Genetic Resources in Indonesia/Editors, Sugiono Moeljopawiro, Machmud Thohari, and M. Herman. - Jakarta: IAARD Press, 2012
vi, 152 hlm.: ill.; 25 cm
575
1. Genetic Resources 2. Agricultural 3. Indonesia
I. Moeljopawiro, Sugiono II. Thohari, Machmud
III. Herman, M.

ISBN 978-979-3919-08-9

IAARD Press

Office:
Jalan Ragunan No. 29, Pasarminggu, Jakarta 12540
Phone: +62 21 7806202, Facs.: +62 21 7800644
Editorial office:
Jalan Ir. H. Juanda No. 20, Bogor 16122
Phone: +62 251 8321746, Facs.: +62 251 8326561
e-mail: iaardpress@litbang.deptan.go.id

PREFACE

Indonesia is the world's largest archipelago compromised 17.508 islands and scattered between six degrees North latitude to 11 degrees South latitude and from nine degrees to 141 degrees East longitude. Spanning more than 5.000 km, Indonesia bridges between the landmass of Southeast Asia and the continent of Australia. The vast archipelago of Indonesia spans three time zones over a width greater than the distance from Dublin to Moscow, or from Florida to Alaska. The nation straddles two of the world's seven major biogeographic regions, the Oriental and Australasian, and includes Wallacea, a unique biotic and geographic area that lies in the broad interface between these two major regions.

Indonesia's historical evolution has been strongly influenced by the sheer forces of it's own geography -- with the interplay between climate, rainfall, and volcanic activity shaping agricultural and population patterns in different ways throughout the country's enormous diversity of islands. Geography has also played role in the remarkable diversity of Indonesia's abundant plant and animal life. The 19th-century British botanist Alfred Russell Wallace and Darwin determined a precise line of demarcation between the Indonesian islands of Bali and Lombok -- the "Wallace Line" -- which separates the flora and fauna found throughout Asia from those unique to Australasia. This country is considered a mega biodiversity country, and is ranked first in the world for the number of mammals, palms, swallowtail butterflies, and parrot species. It contains 10% of the world's flowering plant species, 18 Global 200 ecoregions, 24 Endemic Bird Areas, and has the highest coral species richness in the region. Called as the "Ring of Fire" to refer for the chain of active volcanoes that form its spine, Indonesia also is the sole habitat for several of the world's most unusual living species -- ranging from the menacing Komodo Dragon to a bizarre flower known as Rafflesia, with damp and tropical petals opening more than a meter in diameter.

Those genetic resources are commonly used by local communities using their traditional knowledge, which, unfortunately, most of them simply use the available resources without even caring their conservation. Consequently, some of them are nearly extinct or completely extinct. So far, we have been ratifying the Convention on Biological Diversity as well as the International Treaty on Plant Genetic Resources for Food and Agriculture in relation to access and benefit sharing, however, there is no regulation yet for the access and benefit sharing within the country. Remember that the genetic resources we currently have are not our heritage, but, rather the deposition of our next generation for their future welfare so that we have to take good care of them. Therefore, to have the regulation on managing genetic resources is utmost important, if sustainable utilization of genetic resources is to be realized.

This book gives an overview on the current situation of the genetic resources management in Indonesia as well as lessons learned from the International Organization such as FAO and on the development of new regulation on access to genetic resources and benefit sharing and how to implement it by the developed country (Japan). We hope that this will give better understanding to the policy makers on how important to finalize and pass the Bill on Genetic Resources Utilization and Conservation to the House of Representative of Indonesia for their approval and further enactment.

Bogor, November 2012

Dr. Karden Mulya
Director

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REGULATION

The FAO International Treaty on Plant Genetic Resources for Food and Agriculture and Its Implementation

Shakeel Bhatti

Secretary of Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture, Food and Agriculture Organization of the United Nations, Rome, Italy
E-mail: "Bhatti, Shakeel (AGPD)" <shakeel.bhatti@fao.org>

Introduction

The International Treaty on Plant Genetic Resources for Food and Agriculture was approved by the Conference of FAO in 2001 and entered into force in 2004. Since then, its Contracting Parties have been working together to further develop and implement the provisions of the Treaty, particularly those related to the Multilateral System of Access and Benefit-sharing.

The processes that led to the Treaty began in 1970 as an effort to smooth tensions over access to plant genetic resources. On one hand, most of the world's agricultural diversity existed in developing countries, tropical and sub-tropical areas rich in biodiversity but poor in modern technology and financial resources. On the other hand, the demand for those genetic materials came from developed countries' resources agro-industries and research institutions that had the technology to improve resources as well as the legal means to take advantage of their improvements by claiming intellectual property rights over their innovations.

The ground-breaking mechanism contained in the Treaty recognizes the sovereign rights of States over their own plant genetic resources for food and agriculture and at the same time establishes a system that is efficient, effective, and transparent, both to facilitate access to genetic resources and to share the benefits arising from the utilization of these resources.

Coverage of the Multilateral System

The Multilateral System puts 64 of our more important crops-crops that together account for 80 percent of the food we derive from plants-into an easily accessible global pool of genetic resources that is freely available to potential users. Those crops are listed in the Annex I of the Treaty and include rice, maize, cassava, potato, and wheat, among others crops that produce our food.

On signing the Treaty-there are currently 116 Contracting Parties-, countries agree to make their genetic diversity and related information about the crops stored in their gene banks available to all under the conditions specified in the Treaty.

This gives scientific institutions and private sector plant breeders the opportunity to work with, and potentially to improve, the materials stored in gene banks or even crops growing in fields. By facilitating research, innovation and exchange of information without restrictions, this cuts down on the costly and time consuming need for breeders to negotiate contracts with individual gene banks.

The Multilateral System sets up opportunities for developed countries with technical know-how to use their laboratories to build on what the farmers in developing countries have accomplished in their fields.

The Treaty states in its Article 15 that Contracting Parties to the Treaty call upon the International Agricultural Research Centres (IARCs) to conclude agreements with the Governing Body of the Treaty with regard to *ex situ* collections. At the present moment, a total number of 15 agreements have been signed and the collections of genetic resources made available will continue to grow over the coming years.

The Standard Material Transfer Agreement

Article 12.4 of the Treaty provides that facilitated access under the Multilateral System shall be provided pursuant to a Standard Material Transfer Agreement, and the Governing Body of the Treaty, in its Resolution 1/2006 of 16 June 2006, adopted the Standard Material Transfer Agreement.

This Standard Material Transfer Agreement (SMTA) is the document that is signed every time genetic resources are transferred under the Multilateral System. It is in use since January 2007. To understand the importance of such agreement we must take into consideration the figures collected during the first eight months of operation of the Multilateral System, which report almost 100,000 transfers.

The SMTA contains two fully operational benefit-sharing options. The first option, provides for payment to the Treaty's Funding Strategy of 1.1 percent of the sales of a commercialized product, such as a new crop variety, which incorporates material accessed from the Multilateral System, *when there are restrictions such as patent protection, that result in the product not being freely available to others for research and breeding*. In other words, this benefit-sharing option is linked to the acquisition, use and exercise of certain intellectual property rights.

Under the second option, the user of the Multilateral System can opt for a crop-based payment system, whereby they pay at a lower rate, namely 0.5 percent, on *all* their commercialized products of a particular crop, *regardless* of whether material from the Multilateral System is incorporated in those products, and *regardless* of whether or not they are freely available to others for research and breeding through the exercise of intellectual property or other rights.

The benefits of the System are clear as it facilitates access to crops that represent a high degree of interdependence (rice, wheat, potato, maize, etc). The Treaty is a legally binding instrument and the SMTA reduces the administrative costs and simplifies procedures.

Information Technology Tools

To extend the use of the SMTA, the Secretariat of the International Treaty has developed and distributed two powerful tools. The first one is a cross-platform software called Gene-IT that autogenerates valid SMTAs. Users download, install and run the light application in their computers and a series of windows with questions guide them through the process. The questions are about the origin of the resources and the benefit-sharing option that they prefer. Users only have to input the name of the provider and that of the recipient, make their choice and attach the description of the resources. Then the software, developed from a previous application created by CIRAD, generates the complete agreement that can be printed and signed.

The second tool that the Secretariat has developed is a prototype hosted in a server and helps to identify the recipients while providing a unique identification passport that can be used in the systems of the providers. This avoids users to compile tedious forms with their personal data each time that they order genetic material on-line. After that, the user can select the materials from the catalogues of the different providers and order them trough the web in an easy and secure way. Their personal data is protected. The system also helps recipients and providers to report about the transfers within the system thanks to general statistical tables. The aggregated data is used to evaluate the overall performance of the Multilateral System.

Those tools make the SMTA operations simpler and contribute to manage the potential risk of systemic failure or incoherence as they standardize processes and help to integrate the SMTA operations easily into existing genetic resource information systems. The tools always fulfil three fundamental criteria, namely that:

- They are only voluntary and optional tools to make the use of the system easier for those stakeholders who seek such support. They are not obligatory reporting mechanisms;
- They do not track genetic material that is in the System, but only facilitate the semi-automated generation and conclusion of SMTAs;
- They fully respect the protection of confidential information, as foreseen throughout the world by the law of unfair competition and the legal protection of trade secrets.[1]

Benefit-sharing Mechanisms

The benefit-sharing mechanisms enumerated in the Treaty do not cover only the sharing of commercial benefits, but also information exchange, access to and transfer of technology and capacity building. The exchange of information covers inventories and information on related technologies and research results. The access to and transfer of technology refers to the technology employed for the conservation and use of plant genetic resources. Finally, capacity building includes also education, training, strengthening of facilities and scientific research on plant genetic resources in developing countries.

The recent decisions taken by the Governing Body of the Treaty have set up a detailed framework *for the allocation of funds under the direct control of the Governing Body.* Contracting Parties have agreed upon general principles, priorities, eligibility criteria and operational procedures for the disbursement of the moneys that will be generated within the Multilateral System. The priorities enumerated are (1) information exchange, technology

[1] See, for example, Article 10*bis* of the Paris Convention and Art. 39 of the TRIPS Agreement.

transfer and capacity building, (2) managing and conserving plant genetic resources on farm, and (3) the sustainable use of plant genetic resources.

Farmers' Rights

In its Article 9, the International Treaty recognizes the enormous contribution that the local and indigenous communities and farmers of all regions of the world, particularly those in the centers of origin and crop diversity, have made and will continue to make for the conservation and development of plant genetic resources, which constitute the basis of food and agriculture production throughout the world. It gives governments the responsibility for implementing Farmers' Rights, and lists measures that could be taken to protect and promote these rights:

- The protection of traditional knowledge relevant to plant genetic resources for food and agriculture;
- The right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture; and
- The right to participate in making decisions, at the national level, on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture.

The International Treaty also recognizes the importance of supporting the efforts of farmers and local and indigenous communities in the conservation and sustainable use of plant genetic resources for food and agriculture, including through a funding strategy. In this strategy, priority will be given to the implementation of agreed plans and programmes for farmers in developing countries, especially in least developed countries, and in countries with economies in transition, who conserve and sustainably utilize plant genetic resources for food and agriculture.

Future Implementation Steps

The Treaty is now at a critical stage of implementation. It remains an indispensable instrument of public international law for regulating access to plant genetic resources for food and agriculture and benefit-sharing. The Treaty is the only binding Access and Benefit-sharing System already operational at international level today.

The Treaty and its Secretariat are in an excellent position to develop cooperation with other international organizations. During 2007, the Treaty has been represented in several technical meetings and working groups of the Convention on Biological Diversity (CBD), the First International Technical Conference on Animal Genetic Resources for Food and Agriculture, the Eleventh session of the WIPO Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore, the Annual Meeting of the European Seed Association (ESA) and in the UPOV West and Central Asian Regional Workshop on Plant Variety Protection, among others.

The future steps to continue with the implementation and the improvement of the relevance of the Treaty are focused to strengthen the operation of the Multilateral System in transferring thousands of genetic resources every day within more than 116 countries with legal certainty, low administrative costs, guaranteed benefit-sharing, and practical consistency and reliability for users of the System; and to consolidate the *Funding Strategy* of the Treaty as an operational mechanism, which will ensure the availability, transparency, efficiency and effectiveness of financial resources, and which will prioritize programmes for farmers in developing countries who conserve and use plant genetic resources for food and agriculture.

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Current Policies and Legislation of Genetic Resources Management in Indonesia

Sugiono Moeljopawiro[1] and Suprahtomo[2]

[1]*Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, Bogor, Indonesia and National Committee on Genetic Resources, Bogor, Indonesia*
E-mail: sugionom@indo.net.id

[2]*Bureau of Law and Public Relation, Ministry of Agriculture, Jakarta, Indonesia*
E-mail: suprahtomo@deptan.go.id

Introduction

There has been a growing concern and recognition that biological diversity as a global asset of tremendous value to present and future generations. This was culminated by the adoption of the agreed text of the Convention of Biological Diversity in Nairobi in May 1992. The United Nation Conference on Environment and Development which was held in June 1992 in Rio de Janeiro, Brazil and known as Earth Summit, was the important milestone in the sustainable development where the Convention was open for signature.

Indonesia is a country with a mega biodiversity. Biological diversity is very important for keeping balance ecosystems and biosphere life system. The lost and erosion of biodiversity, which have been due to human activities, caused the unbalance ecosystem on earth, which, in turn, affect human life. Realizing the importance of biodiversity, Indonesia ratified the Convention of Biological Diversity (CBD) in 1994 which was followed by the release of Law No. 5 in 1994 for the ratification of the United Nations Convention on Biological Diversity.

Indonesia is an archipelago of more than 17,000 islands straddling the equator in Southeast Asia. About six thousands of the islands are inhabited. Indonesia has at least 47 distinct natural ecosystems which are rich in plant and animal resources and large number of island endemics, with the total known species about 1.46 million. In addition to the richness to biological diversity, Indonesia is also rich in cultural diversity.

Traditional knowledge has been long established in order to utilize the existing genetic resources for the people welfare. To be able to be a good competitor in the era of globalization, these genetic resources must be utilized sustainably and efficiently. To do this, strategic plan which is formally written in the form of law and regulation need to be established.

In this report will be discussed available Policies and legislations related to access to genetic resources, traditional knowledge and benefit sharing in relation to sustainable use of genetic resources.

Needs and Opportunity

Access to genetic resources, traditional knowledge and fair benefit sharing are all interrelated. Though they may be separated, to get the maximum impact on the utilization of biodiversity they should be dealt simultaneously, that is when we talk about bioprospecting.

Whatever the sector chosen for development, and the strategy adopted, the end products will always reach the economy through variations of the following sequence:

Natural resources
Basic research
Applied research
Product development
Production
Marketing
Distribution

Different types of industry require extremely different types of approach. The key parameter to consider is where in the process of technology and product development the heaviest investments in human and financial capital are needed. For example, in drug development, the most complex parts are basic studies on diseases and clinical testing of potential drugs. Primary screening of molecules is relatively cheap and technologically within easier reach. A country wishes to stimulate the development of a national capacity on drug development, could adopt a capacity development model starting with primary screening to acquire property on molecules and access to know-how in advanced screening, testing and clinical trial at a later stage.

Whatever the field of activity, and the choice of prime actors in the development scheme, the major element for success is a multidisciplinary approach. Moreover, on top of the required training policy, public authority faces hard choices in other fields: legislation and regulation on safety, IPR capacity development, and public information.

Strategy will depend on the type of product, existing and available technology and business strategy envisaged, and on external factors, such as international treaties.

Finally, if a national or regional strategy for bioprospecting related to economic development is to have a chance of succeed, it requires efficient access to financing sources for long term program as much as training and a legal framework.

Access to Genetic Resources

Biodiversity in the form of genetic resources have been accessed for a long time, for various purposes, by researchers, private companies as well as local communities, with little or no returns to conservation activities. In order to utilize genetic resources wisely, there should be two fundamental goals included: (1) sustainable use of genetic resources and their conservation, and (2) socioeconomic development. Therefore, when assessing the genetic resources as a means to improve national capacities to add value to natural resources, and to build the skills, infrastructure and technology to develop business activities, to improve quality of life and contribute to the development of new products for global markets, at the same time ensuring that the resource is protected and used sustainably, through biodiversity prospecting (bioprospecting).

Bioprospecting is notably complex and should incorporate benefits in terms of capacity building and technology transfer for the country as a whole, direct financial benefits for conservation in addition to potential royalties, the involvement of institutions and entities on the local as well as national level, the creation of industrial incentives, and the attraction of industrial activities in general. An integrated set of biological research, business development, technology transfer options and supported by macro-policies are needed to create a bioprospecting program that yields these long term benefits for conservation and for developing countries as a whole.

National policies and legislation to access genetic resources and benefit sharing

Legal norms in relation to policy and legislation may be sought within the traditional systems, science and technology as well as international convention, of which Indonesia had enacted Law No. 24 in 2000 on International Convention. So far, Indonesia had already ratified several conventions through Law No. 5 in 1994 for the ratification of the United Nations Convention on Biological Diversity, Law No. 21 in 2004 on the Ratification of Cartagena Protocol on Biosafety to the Convention on Biological Diversity, and Law No. 4 in 2006 on the accession of the International Treaty on Plant Genetic Resources for Food and Agriculture.

The following are other national legislation related to the natural resources management in general:

1. Law No. 6 in 1967 on the Provisions on Animal Husbandry and Veterinary.
2. Law No. 5 in 1990 on the Conservation of Biological Resources and Their Ecosystems.
3. Law No. 12 in 1992 on Plant Cultivation Systems.
4. Law No. 16 in 1992 on Animal, Fish and Plant Quarrantines.
5. Law No. 41 in 1999 on Forestry.
6. Law No. 23 in 1997 on Environment Management.
7. Law No. 29 in 2000 on Plant Variety Protection.
8. Law No. 41 in 2004 on Fishery.

However, for the genetic resources management related to plant, Article 9 of Law No. 12 in 1992 on Plant Cultivation Systems dealing with the development of new improved variety, exploration and collection, procedures for the exploration, collection and conservation of plant genetic resources. This article was further elaborated in the Government Regulation No. 44 in 1995 (GR 44/1995) on the Seeds.

Article 3 to Article 14 of GR 44/1995 regulate the ownership of genetic resources, who and how to explore, collect, conserve and use genetic resources.

Law No. 6 in 1967 on the Provisions on Animal Husbandry and Veterinary contains the provision on conservation as well as reproduction where purity has to be maintained, and only high quality animal may be used as parent for breeding purposes.

Unlike plant, fish may be migratory, of which the Law No. 41 in 2004 on Fishery stresses the management of fish genetic resources directed toward the achievement of the most usefulness of fish for the Indonesian people. Therefore, fish management shall be done by integrating the need of the people and the need of environmental conservation for the people welfare.

Forest with its ecosystems is not only important for forest trees, but also for genetic resources conservation of indigenous plants. Law No. 41 in 1999 on Forestry has the provision on how to manage our forest.

Law No. 29 in 2000 on Plant Variety Protection provide the protection of the rights of plant breeders to the new plant variety they develop, as well as the intial variety, whether in the form of breeding lines or landraces from illegal use.

In addition, Law No. 23 in 1997 on Environment Management which regulate the management of our environment as a whole for better living together with Law No. 16 in 1992 on Animal, Fish and Plant Quarrantines that prevent the entrance of pests and diseases having potential of destroying our plants, animals and fishes are utmost important in managing genetic resources.

However, these legislations are meant only for conserving genetic resources, nothing is dealing in depth on the access to genetic resources and benefit sharing arising from the use of genetic resources. Therefore, the finalization and enactment of the Bill of Genetic Resources conservation and Utilization is a must.

Currently we have Ministerial Regulation No. 67 in 2006 on Plant Genetic Resources Conservation and Utilization which is meant to anticipate the need of access to genetic resources while the Law on Genetic Resources Conservation and Utilization is not in existence yet. Therefore, future legislation should also consider the incorporation of new legislation and policies clarifying which institutions have the authority and responsibility to grant the access to the nation’s biological resources and on what terms, thus setting the conditions for bioprospecting activities and the ability to monitor them. Estimation of the volume of future request for access, land tenure and ownership, regulatory agencies, separation of land for conservation, capacity to add value to genetic resources and technical, administrative and financial capacity to create and oversee a regulatory program are very important issues to consider.

Genetic resources can be obtained from both *in situ* or *ex situ* sources, whether privately, publicly or communally owned as well as from protected or unprotected areas. The use and free exchange of genetic resources for the economic, religious, and cultural wellbeing of indigenous or local communities are also be considered. Another consideration is the financial support to ensure and enforce the regulatory scheme as well as the management of the financial benefits from bioprospecting.

Policies and incentives to add value to genetic resources

Adequate bioprospecting frameworks must be in place while the relationships between genetic resources and the following elements are understood and nurtured: (1) policies, (2) biodiversity inventory and information management, (3) access technology, and (4) business development and planning.

In exchange to access to genetic resources, the industrial partner must agree to the fair and equitable sharing of benefits, both in the intellectual and monetary terms; implementation of collection and production methods with minimum effects on biodiversity; and the use of equitable bioprospecting practices for further research.

The fundamental policies leading to income generation: governmental and international regulations, laws and economic incentives, intellectual property rights, technology promotion, biosafety issues and industrial development.

Action plan

In order for Indonesia to use genetic resources sustainably and efficiently, in 1982 the National Conservation Plan was established to determine conservation areas. Assessment and analysis of this plan had been conducted in 1993 and 1995 in collaboration with the World Bank. Government policies on the environmental management were: Environment Management Principles Law No. 4 in 1982; Conservation of Natural Resources and their Ecosystems Law No. 5 in 1992; and Ratification of Convention on Biological Diversity Law No. 5 in 1994.

Modern agriculture has been realized to cause diversity erosion, especially the long inhabitant or landraces that have been adapted to their ecosystems. Over exploitation of certain species as well as the development activities disturbing the habitat cause the almost extinction of certain species suggest the important of *ex situ* conservation of such species.

1998-2020

- Assessment of the conservation areas on the basis of the richness in biodiversity, economic, environment, social and cultural values, feasibility, funding and institutional organization.
- Survey and mapping of conservation areas.
- Development of regional conservation program.
- Prevent the extinction of species through *ex situ* Conservation.
- Implementation of the program developed.
- Capacity building.
- Human resource development.
- Science and technology development.
- Policy and institutional development.
- Promote public awareness program at the community, scientists and decision maker levels.
- Apply the Eco-tourism pattern for selected conservation areas to generate income for conservation purposes.
- Extension of the conservation areas.
- Promote people, regional and NGO participation in managing conservation areas.

- Development of national conservation areas network covering forest, ocean and wetland areas including the management and local community.
- Implement new national action plan related to *in situ* conservation in the conservation areas.
- Returning species developed from *ex situ* conservation areas to their habitat.
- Development of data base for management information system of the biological diversity.
- Continue research on taxonomy behavior and physiology of the species as well as habitat ecology.
- Further development of the policies and institutional and capacity building.
- Promote and facilitate the development of germplasm bank at the community level.

Traditional Knowledge

Traditional knowledge on biological diversity has been reflected on the use of genetic resources, traditional agriculture pattern and natural conservation exist within communities in Indonesia. From the utilization aspect, to meet the need for carbohydrate, more than 100 species have been use as sources of carbohydrate. About 100 species of leguminous plants have been used as sources of protein and fat. About 450 species of fruit trees and 250 species of vegetables have been used as vitamin and mineral sources. Spices have been obtained from 70 species, and 40 species for beverages. For furniture and construction, about 300 species have been used. About 1,000 species have been used as ornamental plants. More than 940 species of medicinal plants have been used for traditional medicine.

Traditional knowledge also includes animal and marine resources used as food and traditional medicine. Microorganisms have also been used to produce antibiotic as well as for fermentation processes of foods.

Traditional knowledges will be very useful for future utilization of genetic resources for agriculture and medical health. However, these traditional knowledges are degrading due to several factors. In general traditional knowledge has been developed orally within the local cultural system, which, therefore, in the development processes these traditional knowledge which have not been documented become extinct. This situation is disadvantageous to the development of the genetic resource utilization, which, otherwise, will be utilized by industrial countries that already have the capability to use it. To anticipate the global market in the years to come, these traditional knowledges have to be conserved and protected against commercialization without fair sharing of the benefits.

Program has been developed to maintain the existing traditional knowledge and to invent the almost extinct knowledge that are useful in the use of genetic resources sustainably. The following are plans for the period of 1998-2020.

1998-2020

- Develop data base for traditional knowledge related to the utilization and conservation of genetic resources.
- Develop the policy to protect traditional knowledge.

- Promote and give the incentives to conduct basic study related to biodiversity.
- Development of science and technology related to biological prospecting.
- Establish center of excellence for biological diversity.
- Human resource development.
- To combine modern technology with the traditional knowledge in the management of genetic resources.
- To strengthen research capability useful to biological prospecting.
- Establish policies on traditional knowledge.

Fair Benefit Sharing

The richness in biological diversity in Indonesia, especially the genetic resources which are not all of them have been known and documented, would be an important asset for the future economic development especially as the genetic resources for agriculture and for the invention of new medicines. One of the commercial components of biodiversity which has the potential for development is the traditional medicine, including antibiotic. Aside from direct products, biodiversity has high service value through natural tourism or ecotourism. This should be focused in the conserved areas, which, therefore, activities in the conserved areas is not only for conservation purposes but also its sustainable utilization in the form of not for sale products for the need of local people, medicinal products and ecotourism.

According to the Asian Development Bank there is a large export program of biological materials from Indonesia being negotiated. There also possibility of exporting biological materials by foreign individuals supported by Indonesian person informally. There seems no agreement on the benefit sharing in the case of foreign parties doing collection work of plant or animal for further development. This has been due to the weakness of the existing law or policies as well as lack of coordination.

In order to be able to get fair benefit sharing in the utilization of biological diversity as well as to utilize biodiversity sustainably, the following programs have been set up for the period of 1998-2020.

1998-2020

- Evaluate and analyze the conflicting interest at both local and national levels related to management of the conserved areas.
- To study, develop and implement fair benefit sharing of the utilization of biodiversity, based on traditional knowledge and traditional plants.
- Determine sustainable pattern of biodiversity utilization.
- Develop data base on the biology and potential of the flora and fauna in the conservation areas.
- Analyze economically the fair benefit sharing pattern on the use of biodiversity and the impact of TRIP on the biodiversity.
- Human resource development.

- Develop institutional structure and legal instrument for biodiversity utilization.
- Study the implication of GATT, NNAFTA and TRIP impacts on the biodiversity utilization.
- Develop organization structure, mandate, memberships and program of the Biodiversity Commission at the provincial level.
- Develop data base on the utilization of biodiversity.
- Develop data base on both national and international market demands of the biodiversity products including materials for medicine, genetic resources of the plants and animals, natural dye and preserving compounds.
- Improvement of the existing law(s) and policies.

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Policy on *In Situ* Genetic Diversity in Indonesia

Tonny Soehartono and Ani Mardiastuti

Directorate General of Forest Protection and Nature Conservaton, Ministry of Forestry, Jakarta
E-mail: tsoehartono@yahoo.com

Departement of Forest Resources Conservation and Ecotourism, Faculty of Forestry,
Bogor Agricultural University, Indonesia
E-mail: aniipb@indo.net.id

Introduction

Biodiversity found on Earth today is the result of approximately 4 billion years of evolution, although sciences indicated that life may already well established a few hundred million years ago. As of 2004, scientist recorded almost 100 million of macroscopic species, which include about 287 thousand plant species, approximately 120,000 fungi, and about 1,25 million species of animals, most of them (90%) are invertebrates (Wilson 1988).

The said number are changed rapidly on daily basis as the new species are regularly discovered on average of 5 to 10,000, nearly 90% are insects and many of them have not been classified. On the other hand, the world also losing its species regularly in the great number and according to Species Area theory the lost is almost 140,000 species annually (Ehrlich 1988). This figure indicates that the world is facing unsustainable ecological practices. Scientists have long acknowledge that the rate of species loss is in the alarming rates. Unless appropriate action are taken to protect and conserve the species and its natural ecosystems, the lost of species may continue at a serious level.

The loss of biodiversity has been discussed largely on a species level. Genetic level has been applied mostly for the *ex situ* conservation to maintain the viability of the species target. However, when a population in the wild decreases to an alarming rate due to a certain cause(s), and therefore, when the size of gene pool is limited, the a genetic management of the *in situ* population might be crucial in order to save the species from extinction.

This paper presents an overview on the policy of the Government of Indonesia in managing genetic diversity of *ex situ* population. Some root causes of the loss of genetic diversity and curent situation of the population of some important Indonesian species in the wild will also be discussed.

Biodiversity Loss in Indonesia

There are numbers of causes of biodiversity loss in Indonesia. First, the lost of species due to the increased of habitat conversion and destruction for economic development such as timber production, palm oil, mining, agriculture and urban development. Conversion may eliminate certain species at the very high-speed rate and the causes may be irreparable. Further, habitat fragmentation due to encroachment may also end with similar problem. Fragmentation separates the area into small island (known as 'habitat island'), creates the species into isolation in small groups and, therefore, could fall below critical mass and eventually might disappear.

The second is unsustainable extraction of certain commercial species or product derived from the species within certain area. The unsustainable extraction is often followed by inappropriate harvest practice which – to some extent – cause the destruction of the neighboring species. Large scale of natural catastrophe such as long drought and forest fire may also contribute to the extinction of species. Fire not only destroy the trees and wildlife but also exterminate various fungi, insect and many other microorganisms which serve as pollinator for the flowering trees and decompose the litters. In addition, disease, pest and invasive species may also accelerate the lost of certain species.

Species lost has been occuring in Indonesia since the colonial era. The Dutch has converted most of natural forest in Java into teak plantations. No one recorded at that time the lost of species in Java. But certainly due to excessive hunting and land use changes in Bali, the Bali Tiger *Panthera tigris balica* has gone into extinction in the 1940s and followed by the disappearance of Javan Tiger *Panthera tigris javanica* in 1980s. Other species now in the brink of extinction are Javan Rhinoceros, Sumatran Rhinoceros, Sumatran Tiger, Sumatran Elephants and Orangutan.

The long drought due to El Nino has ignited fire catastrophe in Kalimantan in 1998 and has taken out almost 6 million hectares of tropical forest in East Kalimantan (Syarif 1999). Apart from the said disaster, rampant forest fires also almost regularly occur in Sumatera and Kalimantan. Unlike fire occured in 1998, the later was purposely set as the cheapest and efficient tool to convert a piece of natural forest into large and small scale agriculture. Even though there was only few scientific record on the lost of species in this area due to the fire tragedy, it assures that plenty of flowering species, fungi, insects and other microorganism in the respected area have gone permanently.

Another great lost of biodiversity might also happened in Central Kalimantan during the early 1990s when the Government, for the purpose of national sustainable production of rice, converted almost 1 million hectares of peatland in Central Kalimantan into mega-rice project. Trees and wildlife had gone indefinitely from the area and replaced by the various type of paddy species and commercial freshwater fishes introduced from Java to improve the livelihood of the immigrant farmers.

For years, Indonesia is also known as the biggest producer of lumber, plywood, sawn timbers and many other wood products. These forestry activities and its products have generated large economic incentives for the nation and provide many job opportunities at different skills in many regions. However, this national economic benefit was largely upon the cost of annual harvest of almost 20 million hectares of forest production across the country. It also suggests that these economic activities are also pressurizing on the remaining natural forest throughout the country and may constantly destroying its biodiversity. The aformentioned pictures of Indonesian economic development led to the fragmentation of forest, which has a tremendous impact on the loss of the genetic diversity of various species.

Habitat Fragmentation

Various human activities inevitably have been causing fragmentation of forests, that used to be an excellent and ideal habitat for variety of species. A species is forced to have a discontinuous distribution due to habitat fragmentation. Eventually the habitat fragmentation creates less habitat suitable for a species (‘patch’) and more habitat unsuitable for the species (‘matrix’). In addition, population of a certain species are confined into smaller pockets with less or even no genetic exchange among/between this pockets of populations.

Habitat fragmentation is widely regarded as the central issue in conservation biology lately. When a habitat undergoes fregmentation, remnant patches of the habitat are increasingly isolated in a matrix of altered and often heavily used lands (Frankel and Soule 1981, Wiens 1996). Indonesia experiencing forest fragmentation and isolated population in almost all parts of this country, especially in Sumatra and Kalimantan. Figure 1 illustrates the fragmentation of forest in Kalimantan as habitats of the Bornean Orang Utan *Pongo pygmaeus* in the last seventy years.

Scientists have been developed an approach related to such isolated populations, called metapopulation, first introduced by Levins in 1970 for insects population. Metapopulation simply means sets of subdivided populations. The higher the number of fragmented areas, the bigger the probability of having metapopulation of the species.

The size of the metapopulation within the fragmented area would greatly affect the survival of each metapopulation. If the isolated population is small, it may easily lead to local population extinction. In the case of animals, the causes of extiction may be due to unequal sex ratio, genetic drift, breeding depression due to lack of genetic variability or gene pool, and natural disaster such environmental changes or predators, including human interventions. A good example of a metapopulation of Indonesian species is Sumatran Elephants, which now confined to several pockets in the fragmented forest of Sumatra (Figure 2).

The island of Sumatra has been identified as the most fragmented forest and has the highest rate of forest loss in Indonesia by the World Bank. Many big mammals of Sumatra

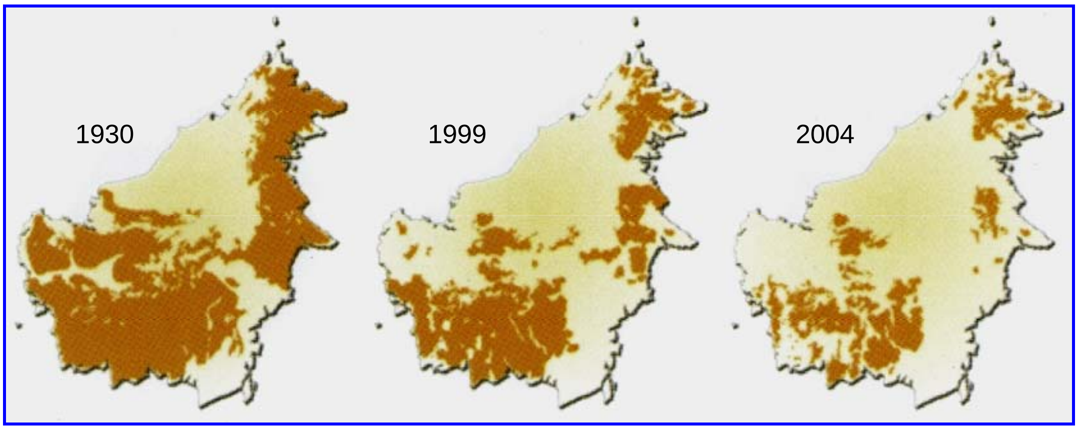

Figure 1. Distribution of Bornean Orang Utan *Pongo pygmaeus* in 1930, 1999, and 2004, showing an increase of population fragmentation over time.

Source: Departemen Kehutanan (2007a).

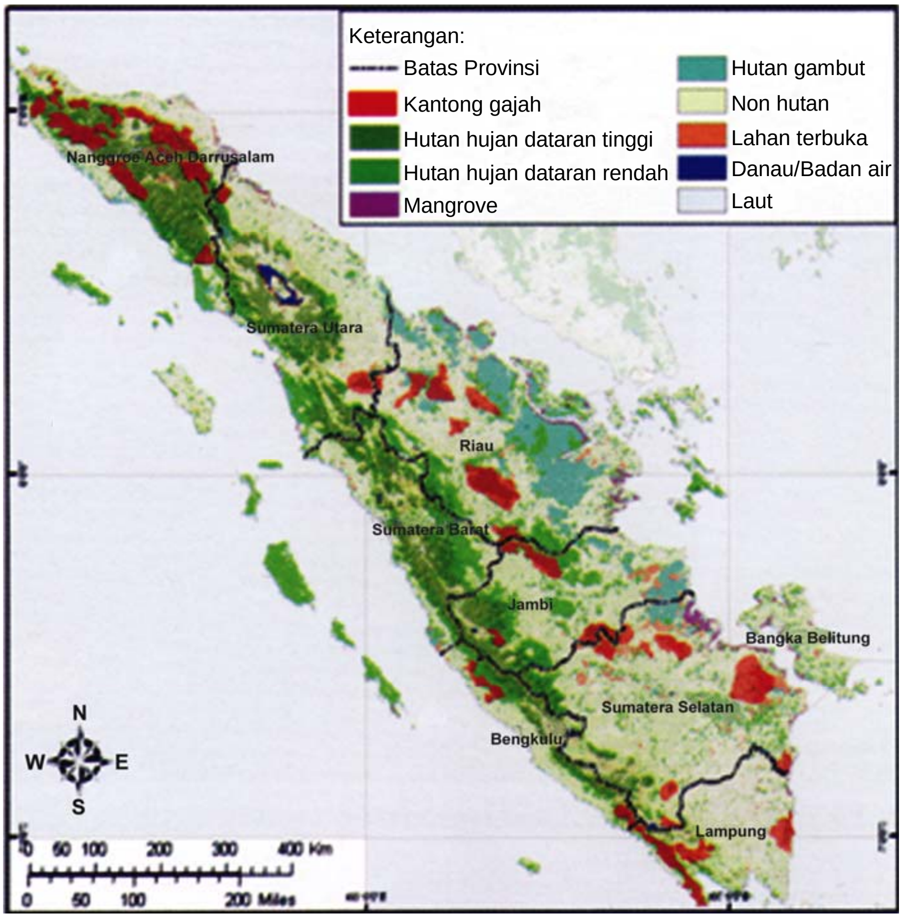

Figure 2. The recent distribution of Sumatran Elephant *Elephas maximus sumatrensis* in Sumatra and its scaterred metapopulation (red shading).

Source: Departemen Kehutanan (2007b).

currently undergone a process related to the creation of metapopulation, for example Sumatran Tiger *Panthere tigris sumatrae*, Sumatran Elephant *Elephas maximus sumatrensis*, Sumatran Orangutan *Pongo abelii,* Tapir *Tapirus indicus*, and Sumatran Rhinoceros *Dicerorhinus sumatrensis.*

This local extinction of a metapopulation is now happening with the Sumatran Rhinoceros in Kerinci Seblat National Park. The park once was famous as an excellent habitat for Sumatran Rhinoceros. Sadly, since 2007 there was no longer indication of the species in the park. Bigger problems may arise when each fragmented forest area only content with small metapopulations of the species. If each population is facing local desepearace, eventually it would reach a complete extiction of the species of the entire wild habitat.

Island Endemic

Some of Indonesian species are geographically limited or known as endemic. The distribution of those species is phisically separated by natural boundary such as island or deliniated by environment condition such as climate or other anthropogenic causes. The examples of island endemic are *Presbytis natunae*, Mentawai primates, Red-and blue Lory *Eos histrio*, Sumba Hornbill *Rhyticeros everetti* and Tanimbar cocatua *Cacatua goffini*; whereas the example of species bounded by ecological condition is the Red Arowana *Sclerophages formosus,* which only occurs in West Kalimantan Province.

The fenomena of the island endemic has lead to the creation of a new sub-species or even a new species. So far, the genetic research on the island endemic species has been focused on higher taxon only, although there are some evidence that the island endemic species is far more often happen in the lower taxa animals such as butterflies and beetles.

The Indonesian Tarsiers are good examples of the fenomena of island endemic. The number of Indonesian Tarsier is still debatable due to the island endemic. Previously, Indonesia has been known to be a home of 3 species of Tarsier (*Tarsius*), namely *T. bancanus, T. spectrum* and *T. syrichta.* Lately, a more detailed morphological and genetic study revealed that some satellite islands of Sulawesi, including Togean Island *T. togeanus*, Sangir Island *T. sangiriensis,* Peleng Island *T. pelengensis*, have distinct characters that probably make the Tarsiers on these island qualified to be a new species.

As these species are restricted to limited ecological circumtances, they are very vurnerable to the environmental changes. Accordingly, unfriendly environmental development would easily affect the survival of such species.

Policy and Effort to Maintain Genetic Diversity

Currently in Indonesia there are two situations which require a great attention in term of genetic management of *in situ* population, namely and habitat fragmentation and island endemic. Unlike the habitat fragmentation which mostly caused human activities, the island endemic is a natural phenomenon which surely need a different approach to conserve its genetic diversity. Currently Indonesia has seven major programs to conserve genetic diversity in the natural habitat of the wildlife.

Establishment of conservation areas

In 1981, the Government of Indonesia has produced a national document regarding the National Conservation Plan (NCP). The document contains proposed areas of terrestrial and marine conservation areas, which included biological and socio-economic assessment of its respective areas in seven bioregion of Indonesia, namely Java, Sumatra, Kalimantan, Sulawesi, Maluku, Nusa Tenggara, and Papua (then called Irian Jaya). Most of the areas designated in the NCP now become conservation areas in various status, including national park, strict nature reserve, wildlife sanctuary and game reserve.

Up to this moment, as mentioned earlier, the terrestrial area dedicated for conservation purposes is approximately covering an area of 28 million hectares. Unfortunately, most of the said areas are located in upland and hilly area, where from the biodiversity point of view, such landscape do not contain the richest biodiversity in Indonesia. The country also has protected most – if not all – catchment areas covering approximately 30 million hectares, to optimize hydrological function and regulate water for irrigation, river transport and freshwater supply, as well as to prevent hydrological disaster in the downstream areas such as flood, land slide and erosion.

In the light of marine species, the Government has also established approximately 10 million hectares consisting mangrove, coastal, fringing and lagoon reefs as conservation areas. Mangroves are not only served as wind breaker to shield the beach area but also to protect area for spawning, breeding, and nursery ground of commercial fishes. For similar purposes, the Government also protects reef areas throughout the country from any destruction activities and promote the reefs as potential marine tourist areas for snorkeling and diving.

With that picture, the significant size of both terrestrial and marine conservation areas could be the source and storehouse of genetic diversity of Indonesian species. Each conservation areas, particularly the terrestrial, represent the uniqueness of diversity of the certain region. For example, Way Kambas National Park represents lowland ecosystem of Sumatra and habitat for Sumatran Rhinoceros, Sumatran Elephant and Sumatran Tiger, whilst Bantimurung Wildlife Reserves in South Sulawesi was established mainly to preserve various unique butterfly species endemic to that area.

Establishment of gene refuge: Gene plasm forest and HCVF

Recent decentralization of authority to the local province and rapid economic development in many regions in Indonesia has not only speed up regional economic development but also escalated the use of natural resources, including forest lands for various perposes such as urban areas, agricultures, energy, mining and plantations. Accordingly, habitats for wildlife in many areas are shrinking, fragmented and/or surrounded by various development activities.

The Government has long aware that rapid and unsustained development might cause such problems. Therefore in 1995 the Government has issued Presedential Decree No. 32/95 on Protection of Ecosystem. This regulation requires relevant stakeholders, including Government, private sectors and Indonesian citizens to protect ecosystem to ensure their function for life support system.

Following this regulation, to avoid further genetic extinction, the Ministry of Forestry through its Ministerial Decree No. 375/Kpts-II/1998 dated 6 April 1998 has produced regulation which requiring each forestry concessionaires to keep at least 200 hectares of its areas dedicated for gene pool bank ('kawasan pelestarian plasma nutfah di hutan produksi'). However, due to lacking consitent enforcement, this regulation has not effectively regulates current rythm of development in Indonesia. As a result, ecosystem degradation and species extinction are still serious problems in Indonesia.

To re-enforce the aformentioned regulations, recently the Government also adopted the concept of High Conservation Value Forest (HCVF) introduced by WWF. This concept requires timber concessionaires and palm oil industries to protect and conserve habitat of wildlife, steep and slope areas, water resources and riparian plain within their concession areas. The approach has received significant support from the global market of timber and oil palm, particularly in Europe and United States of America to help the producer countries to apply environmental sound concept.

Nevertheless, the concept of gene plasm forest and HCVF has not completely resolve the issue of population fragmentation. Additional approaches are still needed to ensure the conservation of genetic resources of *in situ* population.

Creation of ecological corridors

In order ensure that each metapopulation of species isolated by economic development – such as timber plantation, oil palm industries, urban area or mining – would be viable and sustained, the Government has lauched Ecological Corridor Initiative. The corridors would connect each fragmented area inhabited by target species and allow access of isolated or pocket population to join with other pocket population(s) of the same species. This approach would create a network of metapopulation and prevent the process of genetic drift, as well as ensuring that genetic variation of the target species remain high to avoid local extinction.

Up to March 2008, the Ministry of Forestry of the Republic of Indonesia has launched a Management and Action Plans for four large-sized endangered species, namely Sumatran Elephants (including Pygmy/Bornean Elephant), Sumatran Tiger, Rhinoceros (Javan and Sumatran Rhinoceros), and Orang Utan (Sumatran and Bornean Orang Utan). In all four Management and Action Plans, creation of ecological coridors has become a top priority for the *in situ* management of these endangered species, especially in Sumatra.

Currently, the Government is preparing to establish two ecological coridors for the Sumatran Tigers, namely the Dangku Wildlife Reserve – Harapan Rainforest Coridor in South Sumatra and Jambi areas, and Senepis – Giam – Siak Kecil in Riau Province. The coridors connect small patches of Sumatran Tiger habitat and mostly consist of forest concessions and oil palm estates. A more detail Management Plan for the target species in that specific area will be formulated accordingly.

Selection of umbrella species

Along with the scheme of having conservation areas and ecological corridors, to ensure that the nation’s biodiversity would not be degraded, the Government also has adopted a policy option of umbrella species as species conservation priority. The selection of the species depends on the regional specificity, but it should be the top trophic level species or keystone species that may include many other species as well.

Conserving a species at the top trophic level such as Sumatran Tiger also means an effort to conserve various species at the trophic level underneath, including prey species (deer, wild boar, etc.) and their habitat. In Sumatra, the Government has selected Sumatran Elephant and Sumatran Tiger as the umbrella species. Conserving these species requires substantial size of protected habitat and its network. Their habitat also serve as a home to many other endangered wildlife such as Sumatran Rhinoceros, Sumatran Orangutan, Tapir, numerous bird species, reptiles and various plant species.

Conduct genetic research

The survived metapopulation isolated within fragmented forest areas, in theory, over time may evolve depending on the genetic variability and ability to become a sub-species. Nevertheless, to understand the genetic distinctive of each metapopulation, series of genetic research should be performed. The example of an on going studies of genetic variation of metapopulation in Indonesia is Javan Gibbon *Hylobates moloch* within the fragmented habitats in Java (Andayani *et al.* 2001).

Similar studies had also been done on the population of Javan Rhinoceros *Rhinoceros sondaicus* which only confine in the last habitat of Ujung Kulon National Park, at the western tip of Java. Scientific research revealed that Javan Rhinoceros population has a high digree of genetic variation which make them survive over a very long course (Fernando and Melnick 2004).

***Ex situ* and *in situ* links**

When a certain species in the wild fall into a very small number, *ex situ* conservation might be needed as founders to help the population to increase its number. An excellent example of this case is Bali Starling *Leucopsar rothschildi.*

The Bali Starling is endemic to Bali Island and confined to the Bali Barat National Park. The bird is well known for its beautiful appearance and fetch an extremely high price in the black market, despite the fact that this species has been protected by the Indonesian Government. Due to the illegal poaching of their chicks, the wild population has declined to a very low number. In one time, the number of the wild population was less than 20 individuals.

Many years before the starling become rare, an *ex situ* breeding program outside Indonesia was established. The breeding program has been so succsessfull, so that the number of the population in captivity (*ex situ*) exceeded the population in the wild. Following a series of careful assessments, including genetic analysis of birds from *ex situ* breeding operation, a release program of the Bali Starlings originated from *ex situ* conservation was initiated (especially from San Diego Zoo in the USA and Yokohama Zoological Garden in Japan).

The release program, a result of *ex situ* and *in situ* links, has prevented the Bali Starling from extinction in the wild. Further genetic analysis is still needed in the future, especially related to the genetic deterioration due to the bottleneck population and founders effect.

Release program also has been practiced for orang utan, through a rehabilitation activity prior to the release. The orang utan were obtained from various sources, including confiscation and surrendered by the owners. Although the released individuals of orang utan are not from the *ex situ* breeding operation, the release basically has the same purpose of enlarging the gene pool of the orang utan in the wild.

In addition, to sustain genetic variation of species in the wild, the Government has also prepared other regulations dealing with species restoration and rehabilitation into the wild. This law requires any introduction specis into the wild be tested its DNA before releasing into a suitable wild habitat.

Protection of endemic island species

Conserving island species requires genuine involvement of relevant stakeholders relied on the resources occuring in the area where species is present. As mentioned earlier, island species or endemic species is very vurnerable to the environmental changes. Therefore, any human intervention toward the species habitat needs special attention. Concensus need to be made to develop a conceptual model of development which in harmony with the ecological state of the small island. To facilitate that the Government has enacted the Presidential Regulation No. 78 tahun 2005 pertaining the development in small island. This regulation directs and guides any economic intervention within the small island areas.

The establishment of Mentawai Island National Park is an example of the Government policy to protect island endemic species. Mentawai Island (West Sumatra) is the only habitat in the world of four island endemic primates, namely Mentawai Macaque *Macaca pagensis,* Kloss Gibbon *Hylobates klosii*, Mentawai Langur *Presbytis potenziani,* and Pig-tailed Monkey *Simias concolor.* Other national parks dedicated for the island endemic species are Aketajawe-Lolobata National Pak in Halmahera Island (Maluku) and Manupeu-Tanadaru National Park in Sumba, both are gazetted to protect various endemic birds.

Conclusions

Indonesia has laid down the policy for conserving genetic resources since the early 1980s. Conservation areas representing uniques habitat and species as well as coridor between habitat are approaches applied in Indonesia for conserving and preserving biological diversity of its nation. Although the implementation of the concept here and there is lacking consistent enforcement, the approaches have gradually adopted and supported by relevant stakehoders who work in sustainably use of natural resources such as timber concessionares and palm oil industry.

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CONSERVATION AND UTILIZATION

Global Issues Related to Management and Utilization of Genetic Resources: Japan’s Experiences

Seizo Sumida

Japan Bioindustry Association
E-mail: "SUMIDA Seizo" sumidasiz@jba.or.jp, "seizo" <ssumida@whi.m-net.ne.jp>

Introduction

Japan Bioindustry Association (JBA) is a non-profit organization dedicated to the promotion of bioscience, biotechnology and bioindustry. JBA is a unique organization established in 1942 through the support of industry, academia and government. Today, JBA functions as a think tank and a platform for cooperation among scientists, technologists, corporate managers and policymakers.

Since the Convention on Biological Diversity (CBD) entered into force in 1993, JBA has been steadily involved in the process of implementing CBD. That started with the implementation of government-funded projects on research cooperation in conservation and sustainable use of biodiversity with Southeast Asian countries from 1993 to 2000. More than 591 researchers participated in the projects from Indonesia, Malaysia, Thailand and Japan.

Furthermore, since 2002, JBA has been closely involved in another government-funded project to implement the access to genetic resources and benefit-sharing (ABS) provisions of CBD. As part of this project, JBA has been participating in the CBD’s Conference of Parties (COP) and related meetings.

The Ministry of Economy, Trade and Industry (METI) is a competent national authority on ABS in Japan. On behalf of METI, JBA has been helping the private sector and scientific community to continue to build a win-win relationship with other countries in compliance with the CBD principles.

Implementation of the Convention on Biological Diversity and Access to Genetic Resources and Benefit-sharing in Japan

Given below are examples of what we (JBA and METI) have experienced in ABS implementation at national level:

Development of ‘Japan’s ABS guidelines for users’

After the adoption of the Bonn Guidelines at COP6 in Hague, the Netherlands in February 2002, JBA completed translating them into Japanese in September 2002. Using this translated version (http://www.biodic.go.jp/cbd/6_resolution.html), we disseminated the Bonn Guidelines by holding more than 8 public seminars in major cities across the country during 2003 and 2004. This helped to enhance the awareness of genetic resources users (companies and researchers) about the Bonn Guidelines.

As the Bonn Guidelines became better understood, users gave us a number of comments. The two points given below were compelling to us:

a. The Bonn Guidelines are too general in description to be useful for users of genetic resources to cope with practical needs. They emphasized a need for user-specific and user-friendly guidelines.
b. Providing 'Practical Tools' is as important as providing 'Principles'. If practical tools for implementation are not made available, companies would be virtually forced to stop using genetic resources of other countries, and the ABS principles would simply become impediments to sound development of science and technology.

Taking these experiences into consideration, we decided to develop 'user-specific guidelines' on the basis of the Bonn Guidelines. In consultation with our task force consisting of experts from industry and academia, we completed developing "the Guidelines on Access to Genetic Resources for Users in Japan" (the Japan's Guidelines) and published them in April 2005.

The Japan's Guidelines emphasize that the basic premise is to comply with the laws and administrative measures of a providing country, and that, if such national laws or administrative measures are not in place in that country, a contract should be developed with the counterpart, bearing in mind the relevant provisions of CBD and the elements indicated in the Bonn Guidelines (Figure 1).

The Japan's Guidelines aim to help both providers and users of genetic resources to build a win-win relationship, and to minimize the risk of getting involved in problems, while ensuring business flexibility. During 2005 and 2006, we disseminated the Japan's Guidelines by organizing a total of 10 public seminars in major cities across Japan. We are scheduled to continue the dissemination activity beyond 2007. Its English translation is available (http://www.mabs.jp/information/oshirase/pdf/iden_tebiki_e.pdf).

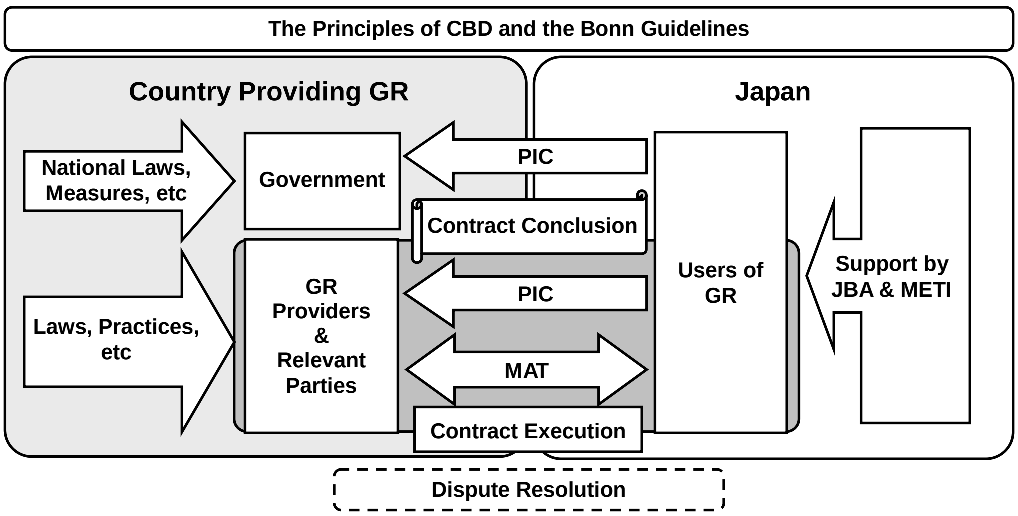

Figure 1. Structure of the guidelines on ABS for users in Japan.

JBA's services for users of genetic resources

On the basis of the Japan's Guidelines, JBA has developed a number of services for users of genetic resources, as 'implementation tools'.

a. JBA's specialized website on ABS rules of providing countries:

   We created a Japanese-language website specialized in disseminating information on ABS-related policy, laws and regulation of different countries, for the sake of Japanese users of genetic resources. If the information on the website is not sufficient to a user of genetic resources, he/she can contact JBA's Help Desk (see below) for further inquiry or consultation.

b. JBA's help desk:

   Because JBA has been involved in the CBD matters since 1993, it has accumulated considerable experiences in diversified situations of diversified countries. Based on these experiences, JBA gives advice, on a confidential and free of charge basis, to those who have questions or problems in ABS matters. In the past two years (2005 and 2006), JBA handled more than 50 cases of such consultation.

c. Workshops in Japan with CBD officials of providing countries and fact-finding visits to partner countries:

   In order to promote development of partnership between users of genetic resources and providing countries, we invite CBD officials (sometimes, CBD experts) to Japan for information exchange at public workshops or meetings. The CBD officials/experts are requested to present information to the audience (mostly, industry experts interested in ABS) on their national policy, laws and regulatory systems relevant to ABS implementation. The workshops also provide the audience with opportunities for direct contact with the CBD officials. We also go to partner countries for fact-finding visits.

So far, we have conducted six such bilateral workshops and four fact-finding visits with Indonesia.

Examples of Bilateral Projects between Indonesia and JBA

1. 1989-Present

   Since 1989, the "Group Training Course in Bioindustries" has been implemented by Japan International Cooperation Agency (JICA) and JBA for capacity building of developing countries. The Training Course has so far invited 180 government officials and researchers in biotechnology-related fields from 30 developing countries for two-months training in Japan. The program of the training course includes lectures, and field trips to public research institutes and different sectors of bioindustry companies. The lectures cover a wide range of subjects, including bioindustry policy-making, trends and status of biondustry, CBD and ABS, bio-safety and intellectual property rights. A total of 23 Indonesian researchers have so far participated in the training course.

2. 1993-2001

   A bilateral project on research cooperation in conservation and sustainable use of biodiversity was conducted between Indonesia and Japan. Japan's New Energy and

Industrial Technology Development Organization (NEDO) and JBA represented the Japanese side. The Indonesian side was represented by Agency for Assessment and Application of Technology (BPPT) on behalf of BPPT, Indonesian Institute of Science (LIPI), Bogor Agricultural University, Gadja Mada University, and Padjadjaran University. A total of approx. 200 researchers from Japan and Indonesia participated in this project.

3. 2002-Present

   A bilateral research project on taxonomic and ecological studies of fungi and actinomycetes has been in progress between Japan's National Institute of Technology and Evaluation (NITE) and LIPI representing LIPI, BPPT, Agency of Agricultural Research and Development (IAARD), University of Indonesia and Bogor Agriculture University.

   This project was triggered by Indonesian initiative. On the occasion of the CBD's COP5 (Nairobi, Kenya) in May, 2000, Dr. Setijati of the Indonesian delegation called for developing ABS Guidelines jointly with Indonesia in an internationally cooperative spirit. In June, 2000, Japan's METI officially informed Indonesia of its willingness to join the Indonesian initiative. In August, 2000, the two countries met in Jakarta and agreed to organize a joint group to conduct a preparatory "kitchen-type" work. The meetings of this group were therefore called 'kitchen meetings'. From August 2000 through August 2001, four kitchen meetings took place in Jakarta between Japanese and Indonesian sides, which led to formation of a concrete concept of a bilateral project on taxonomic and ecological studies of fungi and actinomycetes, in conformity with the ABS provisions of CBD. In March 2002, MOU was signed in Jakarta between Chairman of Indonesia's BPPT and President of Japan's NITE. Since then, intensive joint research activities are going on in both Indonesia and Japan. For Japan, this project has become a model when it organizes a joint research project in microbial taxonomy with other countries.

Concluding Remarks

What is partnership?

National situation is different in different countries. Therefore, domestic needs are different, national policy is different, and, in turn, laws and regulatory systems are different. However, even under these circumstances, different peoples can successfully collaborate if they identify a point of mutual interest. Key to success is mutual understanding and trust. Steps for win-win partnership development would be as follows:

1. Understand each other's situation.
2. Jointly develop practical and effective procedure for collaboration.
3. Help each other to overcome risks and generate benefits.
4. Share the benefits in a fair and equitable manner.

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Development of New Plant Variety in View of the Convention on Biological Diversity - An Example of Collaboration with Argentine

Tomohiro Kamogawa

Sakata Seed Corporation, Japan
E-mail: "Kamogawa" <t.kamogawa@sakata-seed.co.jp>,

Introduction

From the year, 1993 to 2003, The International Cooperative Biodiversity Groups (ICBG) Project funded by the U.S. Government to promote equitable sharing of biodiversity benefits through drug discovery, biodiversity conservation and economic development was carried out in Argentine. The National Genetic Resource Institute (IRB: Instituto de Recursos Biológicos, directed by Ing. Agr. Enrique Suarez) of INTA (Instituto Nacional de Tecnología Agropecuaria) was responsible organization of Argentine.

INTA was also responsible for the Horticultural Development Project (1999-2004) conducted by JICA (Japan International Cooperation Agency). Main objective of this project was to collect plant materials and their accumulation and evaluation as well as research for “floriculture breeding”. It was actually aimed at developing new ornamental plants using native plants in Argentine.

Main objective of this project was accomplished, and in light of its purpose for developing commercially potential flower and ornamental plants, one aspect of such cooperative expedition/evaluation and commercialization program (i.e. CEEP/RWWT), which was additionally included in the project, have been established on a basic concept level. Today, several cooperative projects for the development of new ornamental plants are ongoing in Argentine based on the programs.

A Study of Access and Benefit Sharing Model for Breeding Purpose Using Native Plants Key Elements of Discussion of the Study

Since relevant law covering CBD was not legislated yet in Argentine, adjustment was done by Dr. Suarez’s efforts for the project of ICBG. On the other hand, with regard to the project related to plant breeding, this adjustment was not quite optimal as ICBG which was basically for pharmaceutical sector. The followings are key elements of our discussion from the stand point of peculiarities of development of new plant variety in our horticultural sector.

Multiple plant varieties can be developed from a single source:

Plant breeding often may not be completed only by finding either a single advantageous trait or peculiar characteristic through large-scale screening trials, but it bust be aimed at developing a new variety by combining two or more advantageous characteristics. Theoretically, the possibility to develop new variety is endless but may be expanded depending on combination or hybridization. This fact is quite different from pharmaceutical sector. Therefore, desirable strategy at the source country may not restrict product development from the materials only to a few breeding parties, but establish platform where several plant breeders may proceed to the plant materials simultaneously by arranging minimum possible exclusive rights granted.

A position of private sector in conservation of plant genetic resources:

In case of breeding result is not feasible, breeder may be forced to discard not only every material received, but also developed lines as well. Facing such an event, we have examined, though it was just a rough idea, to include a product development mechanism in the Agreement to enable to keep materials received for conservation purpose or to explore another use by horticultural private sector.

Have we already collected potential plant materials? （Access to "*in situ*" materials before they are lost）

Taking recent success in ornamental plant breeding into account, interest of plant breeders are focused on native plants to improve quality of existing ornamental crop or to establish new ornamental crop by utilizing them. Public Gene Banks are very active in collecting and conserving genetic resources related to food and traditional agricultural crops, but not so much for ornamental plant materials. In contrast, Botanical Gardens have been making astonishing efforts in collecting and keeping records of plant materials for research purposes. With respect to ornamental plant breeding, we consider it is necessary to get access instantly to the places where genetic diversities are kept locally in "native area" to find gene source for pest resistance or to create new color or plant habit for future improvement of new plant variety before they are lost.

To carry out primary evaluation of collected material in the territory of source country: (Not only for evaluation purpose but also for traceability)

For the project of ICBG, traceability of the material was one of the most concerned subjects for INTA. IRB recognized such an important factor and developed a system utilizing DNA analysis technology to identify individual plant material. However, traceability of DNA analysis for cross breeding lines was uncertain. Our conclusion was, therefore, to carry out a primary evaluation in Argentina trial as the first evaluation before transferring the biological materials. This procedure prior to the access provides many advantages for source country. While this is the process that source country can acquire technological knowledge to grow the materials, duplicated plant materials can also be maintained at the source country and only selected plant materials are provided. By realizing a better control over future commercialization of plant derivatives, this system will bring a wide range of collection representing natural plant diversity in *ex situ* for 'sustainable utilization of plant genetic resources'.

Cooperative Expedition and Evaluation Program for New Ornamental Plants (CEEP) Regional and World Wide Testing Program (RWWT)

CEEP program:

Cooperative expedition program:

- Joint expedition to discover plant material participated by cooperator
- Full institutional support to the expedition

Cooperative evaluation program:

- Joint evaluation (first selection) of plant materials collected by above cooperated expedition in a local facility (in Argentine)
- Cooperator will use only selected plant material under appropriate MTA. (First refusal right to be given to participated cooperator during utilization of plant material after trials)
- Plant materials not selected can remain available to other user
- Exclusive use and confidentiality of plant material and/or evaluation data, selected by cooperator and/or obtained through the program, could be considered under mutual agreement between the participated parties.

RWWT program:

- For independent proper breeding program
- Co-operation with local glowers
- Risk management for plant disease
- Local and world wide testing of material/new developed line/variety

Figure 1. Relation of the programs of "CEEP-RWWT"

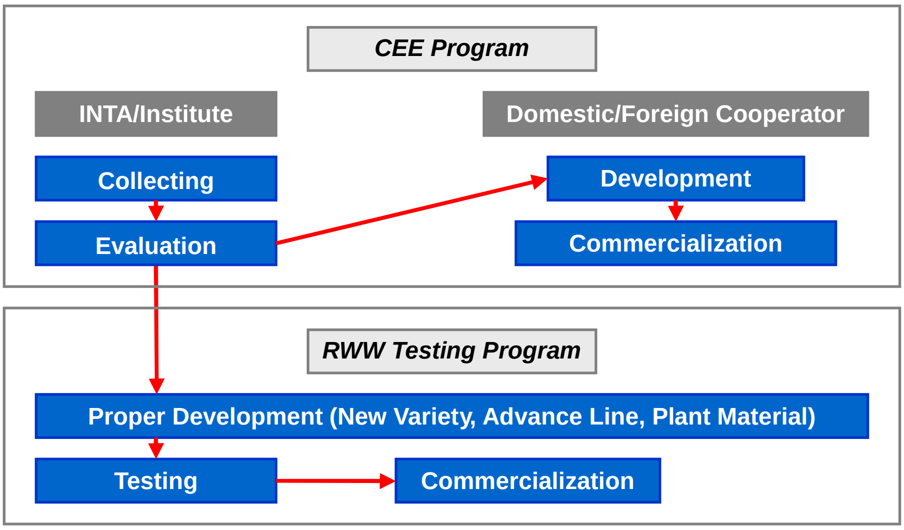

Table 2. Map of responsibilities of each organization of "CEEP"

A co-operation model for Co-operative Expedition and Evaluation Program

	Local Co-operator	Responsible Institute	Foreign Co-operator
Collecting activities			
expedition	x	x	x
technical advice	x	x	x
Matarial consevation activities			
ex situ conservation	x	x	
sample propergation		x	
technical advice		x	x
Evaluation activities			
Field/Pot trials		x	x
Data records	x	x	x
technical advice		x	x
Material transfer activities			
propagation	x	x	
documentation		x	
shipping		x	x
technical advice		x	x

Conclusions

Plant breeding does not always require special installation or large-scale facility for success. Taking breeding efficiency and relevant cost into consideration, it would be recommended for source country to take advantage of own existing natural biological diversity, rather than seeking for expensive and special breeding technologies. Therefore, in case of some breeding technologies have already been established, what source country might require would be to obtain and accumulate knowledge of own plant genetic resources, information of the market place and also its efficient usage for their local plant breeding.

Based on the above understanding, Cooperative Expedition and Evaluation Program (CEEP) has been proposed, that includes joint expedition and evaluation to be conducted by research people both from source country and recipient country of plant materials. Also, through that way, source country could have an opportunity to acquire knowledge and could select useful plant material from the view point of market place. This opportunity can be considered as part of the most important technology transfer in the field of plant breeding under the concept of CEEP.

INTA is planning to proceed with future contracts by employing above mentioned model as an example, but the above case is just one of the solutions for access and benefit sharing under the CBD. Therefore, based on our experience with Argentine, a further improved, mutual agreement is expected for the benefits for both source and recipient countries of plant materials.

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Institute of Floriculture (INTA) Dr. Laura Bullrich (Director). lbullrich@cnia.inta.gov.ar_*CC25 Castelar 1712*, *Argentina.*

Resources database: *http://cirn2.inta.gov.ar/jica/*

Ex Situ Conservation of Indonesian Flora

Irawati

Center for Plant Conservation – Bogor Botanical Gardens
E-mail: irawati@indosat.net.id

Introduction

Indonesian flora consists of the indigenous species, the introduced species, cultivars and hybrids. As part of the rich Malesia botanicalal region, Indonesia share the same borders to Malaysia, East Timor and Papua New Guinea, therefore some of their vegetations are similar. However, many islands of Indonesia have their own specialties. Especially since the eastern part and the western part of the country came from different geological regions, consequently to some extent the flora from both parts are different. This condition makes study on Indonesian flora extremely interesting, especially in many areas which are still untouched and new species to be described attract a lot if botanist from other countries.

The total number of Indonesian flowering plant is estimated 38.000 species. With the endemic plants between 14,800 to 18,500 species, Indonesia is considered to be the second high-endemism nation in the world.

Introduction of flora from other countries to Indonesia have been started almost two decades ago and Bogor Botanical Gardens has an important roles especially for the economically important plantation commodities such as: oil palm, rubber, tea, quinine, cocoa, coffee, cassava, tobacco and others. Study on those introduced plants was very intensive especially on cultivation and the post harvest aspects. Therefore, later those introduced plants became the important commodity for trade. Up to now many fruit trees, ornamental plants and medicinal plants are continuously entering the country enriching the Indonesian flora. Intensive involvement of plant breeders only limited on several groups of plants such as food crops and ornamental plants.

Threats to Indonesian Flora

Human activities directly causing plant loss. In Indonesia the lowland forest is generally being lost at a much higher rate than the mountain forest. Other habitat types such as limestone, coastal ecosystems are also threatened. Tropical forest is considered as an important conservation area due to its richness.

Recently, decentralization of authority over forestry resources has led to serious loss of forest in Indonesia, as regional authorities sought to maximize immediate revenues through giving authority to cut trees.

Conserving Indonesian flora is becoming an urgent task due to the fact that human activities threatening the large number of plants, especially in the lowland areas. The threats are also caused by pollution, invasive species and global warming. It was estimated that more than 13% of the global flora (about 33,798 species) includes 380 species classified as extinct in the wild, 371 species as extinct in the wild or endangered and 14,504 species are rare. These rough figures were considered as a minimum estimate because of incomplete information especially from the tropics like Indonesia. Roles of government are to promote plant conservation by enforcing laws and regulations and to raise public awareness favorable to plant conservation.

Ex Situ Conservation of Indonesian Flora

The most ideal way to conserve plants is in their original habitat (*in situ* conservation). However, most conservation areas in Indonesia are threatened severely, and therefore the *ex situ* conservation would give better chance in conserving Indonesian flora. Collecting of a genetically appropriate and representative sample from their habitat is the beginning of *ex situ* conservation. There is different opinion on the number of population for each species or the number of collection for each population to be collected. It is often found that one species of plant is considered as ornamental plants or medicinal plant or spice, therefore this type of collection will be collected by different *ex situ* conservation organization.

Ex situ conservation facilities for Indonesian flora are found in different institutes or organization as shown in Table 1. *Ex situ* collections are intended to reduce population extinction risk, preserve genetic diversity and provide source of plants/seedlings for restoration and recovery program. To restore genetic diversity of the *ex situ* plant collections, a large area is required, which, therefore, methods of conserving the diversity of Indonesian plants varies from one institute to another institute. Some places restore small number of species but with more genetic diversity. While Botanical Gardens usually conserve a large number of species but with a narrow genetic diversity.

The Department of Forestry with its research institutes and the local forestry offices maintain their plant collections, especially for economically important timber trees. Every

Table 1. Institutes/organization in Indonesia responsible on *ex situ* conservation of plants.

No.	Organization	Plant groups	Type
1.	Department of Forestry	Forest trees	Arboretum
2.	Center for Plant Conservation, Bogor Botanical Gardens, Indonesia Institute of Sciences	Wild flora and introduction from other countries	Four Botanical Gardens + Ecopark
3.	Center Research for Biology, Indonesia Institute of Sciences	Native species	Biology gardens
4.	Center Research for Biotechnology, Indonesia Institute of Sciences	Fruit tree germplasm	Field Collection & culture collection
5.	Department of Agriculture	Food crops, fruits, vegetables and ornamentals	Field collections, seeds
6.	Research Center for spices and medicinal plants, Department of Agriculture	Spices and medicinal plants	Field collections, tissue culture, seeds
7.	Department of Health	Medicinal plants	Field collections
8.	Puspiptek Serpong	Indonesian plants	Field collections
9.	Local government	Wild flora	Botanical gardens
10.	University	Forest trees, botanicalal collections	Arboretum
11.	Private gardens (Mekarsari, Taman Bunga Nusantara, Orchid gardens)	Fruit trees or ornamental plants	Field collections

province, under the Directorate General of Land Rehabilitation and Social Forestry also has nursery and produces seeds of their important local plant collections. Since 2001 to 2005, from 27 out of 33 provinces has a total of 104,201.14 hectares area and their potential production are 29,330,730.13 kg of seeds. There are many garden collections under the Department of Forestry. One of them is under the Forestry Research Center, the area is 5 hectares and holds 234 species of trees (136 genera, 50 families), 167 species are local and 67 are exotic species.

Four Botanicalal Gardens, namely: Bogor, Cibodas, Purwodadi and Eka Karya-Bali are under the Indonesian Institute of Sciences. All gardens not only conserving Indonesian plants but also conserving plants from other countries through routine exchange.

Bogor Botanicalal Gardens mainly conserves plants from lowland humid areas in Indonesia. The important collection of Bogor Botanicalal Gardens is palms, orchids, Indonesian timber, bamboo, medicinal plants, ornamental shrubs and trees, water plants, climbers, lianas, foliage plants. Many important plants were introduced to Indonesia from other country, such as oil palm, rubber, cacao, vanilla and others. The last record of Bogor Botanicalal Gardens conserved 217 families; 1,363 genera; 4,052 species and 22.439 specimens of plant collections. Storage of seeds has been started recently especially for the orthodox seed collection.

Cibodas Botanical Gardens is a mountain garden which mainly conserving plants from the highland humid areas in Indonesia. Important collections of Cibodas Botanical Gardens are fern, Bryophytes, cacti, orchids, Rhododendrons, Gymnosperms. *Cinchona*. The latest record of Cibodas Botanical Gardens has 243 families, 886 genera, 2.044 species, and 9.814 specimens of plant collections

Purwodadi Botanical Gardens is holding collection mainly from lowland dry areas. Purwodadi Botanical Gardens has important collection of succulent, orchids, mango, banana, medicinal plants and others. Recent record of the garden has 174 families; 908 genera; 1,901 species and 10,934 species of plant collections. Purwodadi Botanical Gardens also has a good garden seed collection.

Eka Karya Bali Botanical Gardens is conserving collections from highland areas of the eastern part of Indonesia. Some important collections of this garden are cacti, Begonias, bamboo, medicinal plants, orchid, and ceremonial plants collection. The latest record of this garden has 198 families; 988 genera; 6,471 species and 15,091 specimens of plant collections.

As extension of Bogor Botanical Garden, 30 hectares of land in Cibinong Science Center were developed into *Ecopark.* The arrangement of plants is differ from the botanical gardens because the plant collections were grouped according to the original island in Indonesia (bioregion). Since 2002, Ecopark already has 78 families; 556 genera; 1.850 species; 4.500 specimens of plant collections.

The Biology Garden in Wamena was established in 1995, under the Research Center for Biology, this is the only *ex situ* plant collection in Papua. About 150 local species were planted in more than 200 hectares land area. This garden also maintains cultivars of sweet potatoes, especially from the highland of Papua.

Twenty hectares of *germplasm collection* managed by the Biotechnology Research Center, of the Indonesian Institute of Sciences holding 2,250 collection number; 108 cultivars; of 16 species fruit trees. This garden also has 360 collection number of cassava (120 genotypes), 710 collection numbers of taro (182 genotypes), 693 collection numbers of multipurpose trees from 10 species and 43 collection numbers of *Jatropha curcas*.

The Department of Agriculture holds 10.592 accession of 23 food crops especially rice, sweet potatoes, cassava, peanut, corn, peas, minor legumes and minor tuber crops. The collections consist of field collection and short/medium/long term seeds collections. Under the Department of Agriculture the plantation plants (coconut, nutmeg, clover, oil palm, rubber, tea, cacao, coffee etc.), medicinal and aromatics, fruits, vegetables and ornamental plants collections were in the form of field collection and seeds collection.

Research Center for spices and medicinal plants has 5 gardens, 2 gardens at the highland (Manoko and Gunung Putri) and 3 gardens at the low land (Cikampek, Sukamulya and Cimanggu). The number of collections holds in 5 gardens is 1,116 collection numbers in the form of field collection, tissue cultures and seeds.

Department of Health has 13 hectares area that hold 850 species of medicinal plants collections in Tawangmangu gardens in Central Java.

Puspitek Serpong has 350 hectares land that hold 160,020 number of specimen from 37 families; 378 genera and 602 species.

Recently local government starts building their Botanical Gardens. These new gardens would have important roles especially in conservation of their local flora. Under the guidance of Bogor Botanical Gardens, their collections have been planned according to the themes of the garden. For example, *Sungai Wain Botanical Gardens* in Balikpapan, East Kalimantan focusing on timber trees, *Nepenthes* and orchids. *Enrekang Botanical Garden* in South Sulawesi focusing on Wallace plants. *Bukit Sari Botanical Gardens* in Jambi is the remaining lowland forest among oil palm plantations in that area. This garden was established in 2003 with the area of 300 hectares and about 400 species were found in that garden. *Baturaden Botanical Garden* in Central Jawa is planning to collect Java flora. This garden was established in 2004 with the area of 142.2 hectares and 107 species has been planted in that garden. *Kuningan Botanical Garden* would represent Ceremai mountain flora and plants suitable for stony areas. *Liwa Botanical Garden* in West Lampung is focusing on ornamental plants and plants from South Bukit Barisan. *Katingan Botanical Gardens* in Central Kalimantan is focusing on fruit trees and *Puca Botanical Gardens* in Maros, South Sulawesi focusing on economic plants collections.

Some areas in Indonesia are establishing arboretum, for example in Depok, Purwakarta and Jepara. It was also noted that there are private botanical gardens such as in Ubud (Bali) and Tomohon (North Sulawesi). Other area which has planed to build botanical gardens is Lombok (West Nusa Tenggara), Batam (Riau), Samosir (North Sumatra) and Sambas (West Kalimantan).

Some university also has *arboretums*, especially under the Faculty of Forestry, Agriculture and Biology. *Mulawarman University had already established a botanical garden, Botanical Gardens of Mulawarman University*, Samarinda. In 2001 several times the garden was damaged by fire. However, in 2003 at this150 hectares area, 116 species of about 2,600 trees were found.

Private garden such as *Mekarsari Fruit garden* holds 78 families; 326 species and 14.63 varieties of fruit trees collection and also breeds new fruit trees hybrids. This 264 hectares garden was also act as education garden.

Other private garden, *Taman Bunga Nusantara* collected mainly ornamental plants. There are many plant collectors in Indonesia who propagate and breed their collections. Orchid collectors usually have wild and cultivated orchid species and hybrids. Traditional medicine factory usually has medicinal plants collection. Many ornamental plant nurseries also have private garden collection.

Conclusions

As a party that had ratified the Convention on Biological Diversity (CBD), Indonesia is obliged to pass its provision into national law. Therefore, Indonesia has set a national biodiversity strategy and action plan (IBSAP). Indonesia also pays attention to selected "cross-cutting" issues of the CBD including the Global Strategy for Plant Conservation (GSPC) with its 16 outcomes oriented targets for the year 2010 concerning: information (target 1-3), conservation (target 4-10), sustainable use (target 11-13), education (target 14) and capacity building (target 15-16).

Target 8 of GSPC is "Sixty per cent of threatened plant species in accessible *ex situ* collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes". This target is in-line with the evaluation on palms grown at 35 botanical gardens in 20 countries that suggested that the most effective application of *ex situ* conservation for plant as well as other tropical plant groups is in-country and linked with habitat conservation.

According to Jackson (2001), Indonesia should have at least 67 botanical gardens to conserve the biodiversity of the country. There are different types of *ex situ* plant conservation in Indonesia. A big task for conserving Indonesian plants at *ex situ* conservation area has to be continued before the plants in a high risk area difficult to be found or extinct. Both wide genetic diversity of a small number of collections and a narrow genetic diversity for a big number of collections have to be continued to capture as many as possible the diversity of Indonesian flora. Application of *ex situ* conservation technique such as seed banking for long term storage, tissue culture storage, cryopreservation as well as cultivation in the field need to be further explored. Some new *ex situ* conservation areas in the form of Botanical Gardens are also flourishing in Indonesia. However, the Botanical Gardens are not found in all major islands in Indonesia. Therefore, in the future, location of the new gardens should be better planned to cover every ecoregion in Indonesia.

Networking among *ex situ* conservation organization is needed to promote effective integration and building effective relationship in conserving Indonesian flora through *ex situ* conservation.

Acknowledgement

The author would like to thanks Rismita Sari, Yuyu Suryasari, Sugiarti, and Nurul Sumiasri for providing information for this article.

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The Application of Agricultural Biotechnology for Utilization and Conservation of Plant Genetic Resources

Muhammad Herman[1], Sugiono Moeljopawiro[2], and Ika Mariska[3]

[1]Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, Bogor, Indonesia and National Committee on Genetic Resources, Bogor, Indonesia
E-mail: mherman@indo.net.id

[2]Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, Bogor, Indonesia and National Committee on Genetic Resources, Bogor, Indonesia
E-mail: sugionom@indo.net.id

[3]Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, Bogor, Indonesia
E-mail: borif@indo.net.id

Introduction

According to the definition in Article 2 of the Convention on Biological Diversity, biotechnology is defined as any technological application that uses biological systems, living organisms or derivatives thereof to make or modify products or processes for specific uses. Whereas, agricultural biotechnology is defined as a collection of scientific techniques, including molecular breeding, and *in vitro culture*. Agricultural biotechnology is also including genetic engineering that is used to modify and improve plants, animals and micro-organisms for human benefit.

This paper will review the application of biotechnology for the utilization and conservation of plant genetic resources, particularly on molecular breeding and genetic engineering for crop improvement, and the application of *in vitro* culture for crops improvement and conservation. First chapter on genetic engineering for crop improvement will review research status on development of genetically engineered crops for biotic stresses resistance, abiotic stresses tolerasnce, and crop quality modification, in Indonesia. Chapter molecular breeding in crop improvements will review DNA finger printing analyses of food crops varieties, mapping and qtl analysis of alluminum tolerance in rice, development of blast resistant lines using wild relative of rice, marker aided selection for bacterial leaf blight resistance. Whereas chapter the application of *in vitro* culture for crops improvement and conservation will review somaclonal variation, *in vitro* selection, anther culture, protoplast fusion, embryo rescue, and conservation.

Genetic Engineering for Crop Improvement

In the 1970s, advances in the field of molecular biology provided scientists with the ability to readily transfer DNA-the chemical building blocks that specify the characteristics of living organisms-between more distantly related organisms. Today, this technology has reached a stage where scientists can take one or more specific genes from nearly any organism, including plants, animals, bacteria, or viruses, and introduce those genes into another organism. This technology is sometimes called modern biotechnology. Modern biotechnology today includes the tools of genetic engineering. An organism that has been modified, or transformed, using modern biotechnology techniques of genetic exchange is referred to as a genetically modified organism ("GMO"). There are series main steps in the process of genetic engineering: extracting DNA, cloning a gene of interest, designing the gene, and transformation. Some of the more common transformation methods include the particle bombardment (gene gun), *Agrobacterium tumefaciens* mediated transformation, microfibers, and electroporation.

Global status of genetically engineered crops

The technology of genetic engineering (GE) has been utilized and applied for crops improvements all over the world. At present time the GE technolgy has already produced a lot of different kind of genetic engineering crops (GEC). The most widely used GEC and have already been commercialized globally are insect resistant GEC, virus resistant GEC, herbicide tolerance GEC, and altered oil content GEC. In 1996, the GEC were grown by farmes from 6 countries with the global area of 1.7 million hectars (James 1997). The global area continued to grow for the eleventh consecutive year up to 102 million hectars in 2006 and GEC were grown by 10.3 million farmers from 22 countries, 11 developing countries and 11 developed countries (James 2006). Of the 10.3 million, 9.3 million or 90% were small, resource-poor farmers from developing countries (James 2006). The twenty two countries grown GEC are: Argentina, Australia, Brazil, Canada, China, Columbia, Czech Republic, France, Germany, Honduras, India, Iran, Mexico, Paraguay, Philippines, Portugal, Rumania, Slovakia, South Africa, Spain, Uruguay, and USA (James 2006). This fact gave strong indication that the farmers grow GEC obtained global net economic benefits. In 2006, the global net economic benefits obtained by farmers are $14.4 billion from herbicide tolerant (HT) soybean, $7.5 billion from Bt cotton, $2.4 billion from Bt corn, $927 million from HT cotton, $893 million from HT canola, and $795 million from HT corn (James 2006).

Current status of research and development of genetically engineered crops in Indonesia

Since early 1990, research and development (R & D) on GE for crop improvement have been conducted by various research institutes, universities, and private companies in Indonesia. The complete list of research activities on GE in the different institutes is presented in Table 1. There are several institutes such as Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD) under the Ministry of Agriculture, Indonesian Biotechnology Research Institute for Estate Crops (IBRUEC), and Research Center for Biotechnology (RCB) under Indonesian Institute of Sciences (LIPI), conducted R&D on GE for crop improvement. Whereas, universities which conducted R & D on GE are Bogor Agricultural University (IPB), Bandung Technology University (ITB), Gadjah Mada University, Brawijaya University, Jember University, Udayana University, and Airlangga University.

A. Biotic stresses resistance

Insect pests, plant parasitic nematodes, and plant diseases are biotic stresses that causes an important stresses affecting crop. It can also causes economically significant crop losses annually. In this section, GEC resistant to biotic stresses will be discussed.

Table 1. Current status of research and development of genetic engineering for crops improvement in Indonesia.

No.	Institutes	Research Topic	Gene	Status
1.	ICRABIOGRAD	• Development of transgenic rice resistant to blast and BLB diseases	OsWRKY76	Research
		• Development of transgenic rice for efficient nitrogen utilization	CsNitri1-L	GH, BCF
		• Development of transgenic corn for efficient nitrogen utilization	CsNitri1-L	Research
		• Development of transgenic papaya for delay ripening	*Antisense ACC Oxidase*	SH, BCF
	Collaboration ICABIOGRAD and IVEGRI	• Development of transgenic potato resistant to *Phytopthora infestans*	RB	GH, BCF, and CFT
	Collaboration ICABIOGRAD and IVEGRI and BAU (IPB)	• Development of transgenic tomato resistant to CMV and gemini virus	*Coat Protein* (CP)	SH, BCF
		• Development of transgenic tomato for parthenocarpy (seed-less)	defH9-iaaM dan defH9-RI-iaaM	GH, BCF
	Collaboration ICABIOGRAD and RCB, IIS (LIPI)	• Development of transgenic cassava for free amylose and tolerant herbicide	*IRC-GBSS*	CFT
		• Development of transgenic rice resistant to stem borer	*cry*1Ab	GH, BCF
		• Development of transgenic soybean resistant to pod borer	*pin*II	GH, BCF
		• Development of transgenic peanut resistant to Pstv	CP	GH, BCF
2.	IBRIEC	• Development of transgenic cacao resistant to fruit borer		Research
		• Development of transgenic coffee for flowering gene		Research
	IBRIEC collaboration with BTU (ITB)	• Development of transgenic mangostine for early flowering		Research
		• Development of transgenic sugarcane tolerant to drought	*P5CS*	Research
3.	RCB, IIS (LIPI)	• Development of transgenic rice resistant to stem borer	*cry*1Ab, *cry*1B-*cry*1Aa, *cry*1B	CFT
	RCB, IIS (LIPI)	• Development of transgenic rice tolerant to drought	*Hd-Zip* (*oshox*)	GH, BCF
		• Development of transgenic rice resistant to blast and *Rhizoctonia solani*	*entC, pmsB*	GH, BCF
	Collaboration RCB, IIS and ICABIOGRAD	• Development of transgenic cassava for free amylose and tolerant herbicide	*IRC-GBSS*	CFT
4.	BAU (IPB)	• Development of transgenic potato resistant to *Fusarium* and plant parasitic nematodes	*chitinase*	GH and Research
		• Development of transgenic peanut resistant to Pstv	CP	GH
		• Development of transgenic hot pepper resistant to virus diseases	ND	Research
		• Development of transgenic soybean tolerant to Al toxicity	*Mamt2*	Research
		• Development of transgenic rice tolerant to drought	*trehalose*	Research

Table 1. Continue.

No.	Institutes	Research Topic	Gene	Status
5.	BTU (ITB)	• Development of transgenic teac wood for delay flowering	ND	Research
	Collaboration BTU and IBRIEC	• Development of transgenic mangostine for early flowering		Research
		• Development of transgenic sugarcane with low calory of sugar content (palatinosa)	*palI*	Research
6.	Brawijaya University	• Development of transgenic citrus resistant CVPD disease		GH
		• Development of transgenic citrus resistant to fungal pathogen	*chitinase, glucanase*	Research
		• Development of transgenic soybean resistant to fungal pathogen	*chitinase, glucanase*	Research
		• Development of transgenic abaca resistant to fungal pathogen	*chitinase, glucanase*	Research
		• Development of transgenic jatropa resistant to fungal pathogen	*chitinase, glucanase*	Research
7.	Udayana University	• Development of transgenic citrus resistant CVPD disease	ND	GH
		• Development of transgenic soybean for high albumin content	ND	GH
		• Development of transgenic soybean for high productivity	ND	GH
8.	Jember University	• Development of transgenic sugarcane for higher randement	ND	GH
9.	Gadjah Mada University and Airlangga University	• Development of transgenic cabbage resistant leaf spot diseases	ND	Research
10.	PTPN XI	• Development of transgenic sugarcane tolerant to drought	*betA*	CFT
		• Development of transgenic sugarcane for higher randement	ND	Research
11.	Indah Kiat Co.	• Development of transgenic teac wood resistant to insect pests	ND	Research

ICABIOGRAD = Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development; IVEGRI = Indonesian Vegetable Research Institute; ITFCRI = Indonesian Tobacco and Fiber Crops Research Institute; RCB = Research Center for Biotechnology; IIS = Indonesian Institute for Sciences; IBRIEC = Indonesian Biotechnology Research Institute for Estate Crops; BTU = Bandung Technology University; GH = green house; SH = screen house; ND = no data; BCF = biosafety containment facility; CFT = confined field trial; Modification of Mulya *et al*. 2003.

However, the main focus will be on GEC resistant to insect pests, fungal, bacterial, and viral diseases.

1. Insect resistance

There are several genes used in the delopment of insect resistance GEC, such as *Bt endotoxins*; *proteinase inhibitor* (*pin*), *cowpea trypsin inhibitor, a* gene encoding *snowdrop lectin Galanthus nivalis* agglutinin (GNA); and *amylose inhibitor* (Herman 2002). In this section will review GEC contained Bt and pin genes. Insect resistance GEC will reduce yield losses caused by insect pests which should lead to reducing farmers use of chemical insecticides.

Bt gene which is a gene derived from a species of soil bacteria *Bacillus thuringiensis* (*Bt*) to produce toxins for resistance to insects (Herman 2002). Bt forms crystal (*cry*) δ-endotoxins which act by selectively binding to specific sites localized or receptors on the brush border midgut epithelium of susceptible insect species target. Following binding, cation-specific pores are formed that disrupt midgut ion flow and thereby cause paralysis and death (Gill *et al*. 1992). There are several of *cry* genes used in developing Bt crops, these are the examples: *cry*1A(a), *cry*1A(b), *cry*1A(c), *cry*1F, *cry*2A(b), *cry*3B(b1), *cry*3A(a), *cry*9C *cry*3A(a) (Herman 2002).

Proteinase inhibitors (*PIs*) are small proteins that are quite common in nature. *PIs* are natural defense-related proteins, which often present in seeds and induced in certain plant tissues by wounding or insect damaged. They play a potent defensive role against insect pests and pathogens. The defensive capacities of plant PIs rely on inhibition of proteases present in insect guts or secreted by microorganisms, causing a reduction in the availability of amino acids necessary for their growth and development (Herman 2002). Proteinase inhibitor II (*pin*II), a serine proteinase inhibitor with trypsin and chymotrypsin inhibitory activities, occurs in many *Solanaceae* plants, including tomato, potato, and tobacco (Herman 2002).

a. Bt rice

Stem borer is one of the most devastating insect pest on rice in many Asian countries, including Indonesia. There are several species of stem borer (SB) of rice, such as white SB (*Scirpophaga innotata* Wlk), yellow SB (*S. incertulas*), striped SB (*Chilo suppressalis*), pink SB (*Sesamia inferens* Wlk), shining-head SB (*C. auricilius* D), and black-head SB (*C. polychrysus* M), however the most important SB in Indonesia, are yellow and white SB. The caterpillars or worm of yellow or white SB, bore into the rice stem, make hollow, and feed inside stem. The SB causes "dead heart" in the vegetative stage, ultimately leading to "white head" in the reproductive stage. Severe damage can cause complete crop loss. Chemical control has proven to be ineffective because the insect larvae feed inside the stem pith and remain out of the reach of the pesticide.

Research on the development of GE rice for resistant to yellow SB (*S. incertulas*) and white SB (*S. innotata*), were conducted by group of researchers from ICABIOGRAD (BB-Biogen) since 1997 (Hanarida *et al*. 1998). *Cry*1A(b) gene was transformed into rice genom using particle bombardment. Rice varieties used in the study were Indica rice, Cisadane and Sintanur varieties, and Japonica rice Taipei 309 (T309) variety (Hanarida *et al*. 2002). Among rice varieties used in the particle bombardment transformationtrans, only T309 showed very responsive (Hanarida *et al*. 2002). From molecular analysis using PCR showed that putative Bt rice T1, T2, and T3-generation (G) there were ten plants positive PCR which comprised two plants T1-G, seven plants T2-G, and one plant T3-G (Santoso *et al.* 2002). The results of bioassay test of T1-G, T2-G, and T3-G showed that 10 plants expressed resistant to high-resistant to yellow SB (Dewi *et al*. 2002).

Putative Bt rice plants from T4-G and T5-G, were grown in the biosafety containment (BC) greenhouse for bioassay test with yellow SB and molecular analysis using PCR and immunostrip (Ambarwati *et al*. 2004). The results of molecular analysis showed that there were 38 plants of T4-G having PCR positive (45.8%) and 31 plants having immunostrip positive (37.4%). Whereas, the results from T5-G showed 85 plants expressing PCR positive (51.1%) and 50 plants expressing immunostrip positive (30.3%) (Ambarwati *et al*. 2004). The results of bioassay with yellow SB showed that there were 25 plants T4-G expressed resistant-high resistant in the vegetative stage ("dead heart") and 28 plants in the reproductive stage ("white head"). Whereas the results from T5-G plants, showed 22 plants have resistant-high resistant in the vegetative stage ("dead heart") and in the reproductive stage ("white head") (Ambarwati *et al*. 2004).

Another research activity on the development of BT rice resistant to yellow SB were conducted by Estiati *et al*. (2006) at RCB LIPI. Rojolele rice variety was transformed using *cry*1Ab gene. Several lines of Bt rice were obtained. One T6-G which contained *cry*IAb showed resistance to yellow SB (*S. incertulas* Wlk) in confined field trials (CFT) in Karawang and Indramayu, West Java (Estiati *et al*. 2006). The percentage of yellow SB damage on Bt rice 6.11(+/-) line showed 5%, compared 21% on non GE Rojolele and 50% on non GE IR42 (Estiati *et al*. 2006). The Bt rice was assesed for invironment safety in CFT for three years. The results showed that there was no different in population of natural enemies and non-target organisms (including soil microorganisms) in plot of Bt rice and non Bt rice (Estiati *et al*. 2006).

In addition to *cry*1Ab, Estiati *et al*. (2006) from RCB LIPI used *cry* fused genes (*cry*1B-*cry*1Aa) and *cry*1B gene, with a wound induceable promoter *mpi* to engineer another Bt rice. Bioassay was conducted to test the putative Bt rice which PCR positive contained *cry*IB-*cry*IAa genes or *cry*IB against yellow SB. The results of bioassay showed that the Bt rice expressed resistance to yellow SB with degree of resistance with scoring of 0-1, compared to non Bt Rojolele rice had scoring of 9 (Estiati *et al*. 2006).

b. GE soybean containing *pin*II gene

Etiella zinckenella is an important pod feeder insect of soybean in Indonesia. Without pest control, pod borer could cause 90 percent yield loss (Nurdin *et al*. 1995). The failure of chemical control to pod borer was mainly due to no contact of the insecticide to larvae, since the larvae live inside soybean pod in a certain period.

Pardal *et al.* (2004, 2005) from ICABIOGRAD conducted research on the development of GE soybean resistant to pod borer (*E. zinckenella*). They transformed *pin*II gene into genom of soybean Wilis and Tidar varieties. They compared particle bombardment and *A. tumefaciens* mediated transformation (Pardal *et al*. 2004, 2005). The results of transformation studies and molecular analysis showed that Wilis transformants gave respond on *A. tumefaciens* mediated transformation and positive PCR containing *pin*II gene (Pardal 2004, Pardal *et al*. 2004). Whereas, Tidar transformants showed very responsive for the transformation using particle bombardment, and expressed positive PCR (Pardal 2004, Pardal *et al*. 2005).

GE soybean Tidar and Wilis varieties which showed positive PCR for the presence *pin*II gene, were grown in the BC greenhouse for bioassay testing with soybean pod borer (*E. zinckenella*). T1-G plants of Tidar and Wilis varieties were grown for bioassay againts *E. zinckenella* in biosafety containment greenhouse at ICABIOGRAD. The results of bioassay showed that GE soybean Wilis had infestation rate (IR) 45.4% (20-60%) and GE soybean Tidar had IR 58.8% (35-75%), compared to IR 96.5% on non GE Wilis and IR 95,5% on non GE Tidar (Pardal 2004).

2. Other biotic stresses resistance

The devopment of GEC resistant to other biotic stresses will be discussed here, are resistant fungal, bacterial, and viral diseases. The available genes used in the devopment of GEC resistant to fungal, bacterial, and viral diseases are: chitinase, glucanase, RB genes (for fungi); replicase and coat protein (for virus).

a. GE rice resistant to fungal and bacterial diseases

Bacterial leaf blight (BLB) of rice, caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is one of the important disease of rice. Subsequently, its incidence has been reported from different parts of Asia including Indonesia, northern Australia, Africa and USA. The disease is known to occur in epidemic proportions in many parts of the world, incurring severe crop loss of up to 50% (Kardin dan Hifni 1993). Another important fungal disease is rice blast. Rice blast is caused by the Ascomycete fungus, *Magnaporthe grisea* Barr (anamorph *Pyricularia grisea* Sacc., synonym *P. oryzae* Cav.). Rice blast is a problem almost everywhere that rice is grown. This fungal disease is estimated to cause production losses of US$55 million each year in South and Southeast Asia.

1) GE rice containing CsWRKY76 gene

Researchers at ICABIOGRAD conducted research activities on the development of GE rice resistant to BLB (*X. oryzae* pv. *Oryzae*) and blast (*M. grisea* or *P. grisea*) diseases by using over expression strategy. OsWRKY76 gene was isolated from rice Nipponbare variety, and constructed using 35S promoter and terminator by Kurniawan R. Trijatmiko (pers.com.). OsWRKY76 gene was transformed into rice genom of Nipponbare variety using vector *A. tumefaciens*. The transformation activities resulted in 750 plantlets from 150 events. Among 150 events, plantlets from 34 events were molecular analyzed using PCR. The PCR results showed that all 34 events were positive. From 34 events, 24 events were analyzed using Southern Blot, and the results showed varies in copy numbers, from 1-5 copies. T1 seeds of GE rice were grown for bioassay againts BLB.

2) GE rice containing *entC* and *pmsB* genes

Research on the devlopment of GE rice resistant to blast (*M. grisea* or *P. grisea*) was conducted by research team at RCB LIPI (Loedin *et al*. 2006). The *entC* and *pmsB* genes were used for rice transformation. The *entC* gene was isolated from *E. coli,* whereas *pmsB* gene was isolated from *Pseudomonas.* Both genes are encoding salicylic acid. The *entC* and *pmsB* genes with hygromicine (*hpt*) selection marker were transformed into rice The GE rice transformants were grown and challenged with *M. grisea*. The results of bioassay showed that there was one line of GE rice had resistance to blast disease genome. (Loedin *et al*. 2006).

b. GE crops resistant to fungal and viral diseases

Late blight, caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most dreaded diseases of potato worldwide, including Indonesia. Late Blight, which can cause a yield loss between 12-31 percent in the field depending on the level of infestation, season (dry or rainy), altitude, and potato variety, but have also been known to cause yield losses of up to 100 percent. The geminiviruses, Tomato Leaf Curl Virus (ToLCV) and/or Tomato Yellow Leaf Curl Virus (TYLCV), pose the most imminent threat to tomato production world wide including Indonesia. Cucumber Mosaic *cucumovirus* (CMV) is the second most prevalent virus disease of tomato in Indonesia.

1) GE potato containing RB gene

Durable resistance to Late Blight is controlled by many genes and is very difficult to incorporate into commercially acceptable varieties. Researchers at the University of Wisconsin (UW) identified, mapped and cloned a resistance gene, termed “RB”, from *S. bulbocastanum,* and subsequently transformed it into the popular US variety “Kathadin” (USAID 2004a). Transgenic *Kathadin* lines have been field tested for two years in Minnesota, Wisconsin, and Washington State, and by researchers at the International Potato Late Blight Testing Program Toluca, Mexico, (PICTIPAPA) and promising selections have been made (USAID 2004a). Results from these various field trials indicate that the RB gene provides good early-season control of Late Blight. Early-season control of Late Blight is more important than very late-season control. In spite of the single R gene, control is not race-specific (USAID 2004a).

GE potato Katahdin variety contained RB gene, *event* SP904 and SP951 engineered by research team from UW, was tested for resistance to *P. Infestans* in confined field trial (CFT) at Indonesian Vegetable Research Institute (IVEGRI) in Lembang, West Java (Herman *et al*. 2007). Natural infestation of *P. infestans* was observed on Atlantic (susceptible potato variety) at 33 days after planting (DAP). At 66 DAP, susceptible varieties such as Atlantic, Granola, and non GE Katahdin were severely damaged, and even completely dead on Atlantic and non GE Katahdin. Whereas, GE potato

(Katahdin *event* SP904 and SP951) showed resistance against *P. infestans* ras Lembang, Indonesia (Herman *et al.* 2007).

The GE potato *event* SP904 and SP951 were crossed with Atlantic and Granola varieties. The crossings were conducted at ICABIOGRAD and IVEGRI (Herman *et al.* 2006). The F1 progenies of the crossing were grown and analyzed by PCR at ICABIOGRAD, to determine the presence of RB gene. The results of PCR analysis showed as follow: Granola x SP904 (26.1% positive PCR), Granola x SP951 (44.1%), Atlantic x SP904 (33.3%), and Atlantic x SP951 (49.6%) (Herman *et al*. 2007).

RB gene which was cloned and constructed by researcher from UW, was mediated transformed using *A. tumefaciens* into genom of Granola variety by research team in ICABIOGRAD (Herman *et al.* 2006). Ninety five potato transformants (T0-G) were obtained. PCR analysis was conducted to determine the prsence of RB gene in Granola transformants. The results showed positive PCR on 50 transformants from 20 independent events, contained RB gene (Herman *et al*. 2007).

2) GE potato containing chitinase gene

Chitinase gene was isolated and cloned from bacteria *Aeromonas caviae WS7b* by Malik *et al*. (2003) from BAU (IPB). The *Chitinase* gene was transformed into potato Desiree variety by Armini Wiendi (2005) from BAU (IPB). The GE potato contained chitinase gene has been challenged to *Fusarium oxysporum*, and showed resistance to the fungal pathogen (Armini Wiendi 2005).

3) GE tomato containing coat protein gene

Two conventionally bred TYLCV-resistant elite tomato lines (FLA456 and FLA478) and two events of CMV coat protein-mediated resistance tomato lines (R7-110-11 and R7-51-12) derived by AVRDC, have been tested for resistance to both viruses respectively in AVRDC. The results showed that the four different tomato lines resistant to TYLCV and CMV respectively (USAID 2004b). The four AVRDC lines used as donor parent, and were crossed with Indonesian tomato varieties (Gondol Hijau, CL6046, Opal and Intan) as recurrent parent, and resulted F1 progenies (Santoso 2005). All the materials were transferred from AVRDC to Indonesia.

Seeds of parental lines and F_1 between CMV-CP mediated resistant lines and local varieties are grown in biosafety containment in ICABIOGRAD, Bogor. Screening of parental lines and F1 progenies for TYLCV and CMV resistance has been undertaken. Screening/efficacy test of parental lines and F1-TYLCV hybrids plants (non-GM) was conducted by using whitefly-mediated inoculation of Indonesian TYLCV at the screen-house of Bogor Agricultural University (BAU) and followed by plants maintenance in the screen-house at ICABIOGRAD. The result of efficacy test of parental lines and F1-TYLCV hybrids showed that the response of geminivirus infection on resistant lines (source of resistance gene, FLA456 and FLA478) showed that FLA456 is more resistant than FLA478. Most of F1-TYLCV hybrids showed also the high resistant level following the infection. In other hand, Indonesian commercial varieties (Intan and CLN6046) showed that most of them were severely infected by the virus (Hendrastuti *et al.* 2006). Furthermore, the resistant F1-TYLCV hybrids are used as a materials for intercrossing/double crossing with the resistant F1-CMV hybrids to combine conventionally-bred virus resistance with transgenic virus resistance (Hendrastuti *et al.* 2007).

B. Abiotic stresses tolerance

Abiotic stresses such as drought, extreme temperatures (high, cold and freezing), excessive salinity, and toxic cause by heavy metal are major limiting factors for plant growth and crop productivity. Abiotic stresses can directly or indirectly affect the physiological status of plants by altering its metabolism, growth, and development.

Drought tolerance

Abiotic stress particularly drought, is a major environmental constraint to crop production especially in non-irrigated lowland upland areas. Drought can cause severe damage at any stage of growth and development of certain crop like rice and sugarcane, which leads to yield loss. Rain-fed lowland, and upland crop ecosystems are most prone to drought stress, but some irrigated land is also prone to drought, especially in the dry season when irrigation water is in short supply.

Drought tolerance is a complex trait, expression of which depends on action and interaction of different characters like morphological such as leaf rolling, reduced leaf area, long of rooting system, etc.; physiological like closure of stomata, high water-use efficiency, reduced transpiration, etc.; and biochemical such as accumulation of proline, polyamine, trehalose, increased nitrate reductase activity, etc (Karim *et al*. 2007). The techniques for gene transformation of crop plants have been applied for identification of genes responsible for drought tolerance and their transfer. There are several genes used for developing drought tolerance GEC, such as *trehalose*, *GmTP55*, *CBF3/DREB1A*, *betA* and *betB*, *HVAI1*, *OsMYB3R-2*.

1. GE sugarcane tolerance to drought

Fitranty *et al*. (2003) from IBRUEC, transformed *P5CS* gene into sugarcane genom of PS 851 clone, via *A. tumefaciens.* Results of PCR analysis showed that the GE sugarcane positive contained *P5CS* gene*.* To determine the expression of *P5CS* gene, proline analysis was conducted. The results of proline analysis showed that non GE sugarcane had proline content 0.2 mM/g, whereas 12 lines of GE sugarcane had varies in proline content from 0.05-0.65 mM/g (Fitranty *et al*. 2003).

Research activity on development of GE sugarcane tolerant to drought was developed using another gene which was *betA* gene. The research activity was conducted by Murdyatomo (2003). Gene of *betA* was isolated from sugarbeet, which was transformed into sugarcane genom using *A. tumefaciens* (Murdyatomo 2003). GE sugarcane contained *betA* expressed some degree of tolerance to drought when they were tested in the geenhouse and screenhouse of PTPN XI in Surabaya, East (Murdyatmo 2004). CFT of GE sugar cane tolerant to drought was conducted by the PTPN XI in Jatiroto, East Java in 2005 and 2007 (TTKHKP 2005, 2007).

2. GE rice tolerance to drought

Droght tolerance GE crop was also developed by Loedin *et al*. (2006) from RCB LIPI. *Hd-Zip* (*oshox*) gene was isolated from rice (*O. sativa*). The *Hd-Zip* (*oshox*) gene with hygromicine (*hpt*) selection marker was transformed into rice genome Rojolele and IRAT 112 varieties. PCR analysis of first generation (T0) GE Rojolele showed that there were six lines contained *oshox* gene (Loedin *et al.* 2006). The results of PCR analysis of *hpt* gene on second generation (T1) of GE rice showed 14 lines expressed the *hpt* gene, and followed the Mendelian segregation (3:1) (Loedin *et al.* 2006).

C. Modification of crop quality

1. Delay ripening crops

Ethylene is the main trigger for fruit ripening, sothat several genetic engineering strategies involve the reduction or prevention of ethylene production. There are several genes employed to genetically-engineer for delay ripeing: *ACC synthase, ACC oxidase, ACC deaminase* (a gene from the soil bacteria *Pseudomonas chlororaphis*), and *SAM hydrolase* (from the *E. coli* T3 bacteriophage).

Antisense ACC oxidase gene was successfully cloned and the antisense gene has been constructed. The gene was transformed into papaya genome Burung variety by using a particle bomboardment (Damayanti 2005). The results of PCR analysis of 25 transformed papaya plants (T0) showed that four transformed papaya lines (TR6, TR9, TR20, and TR24) exhibited a positive response with the size of an 800 bp fragment, which corresponds to the inserted antisense ACC oxidase gene. The four lines of T0 DR papaya were propagated and grown in screenhouse of biosafety containment facility at ICABIOGRAD. Fruits of four lines TO DR papaya were assesed to determine how many days the DR papaya can prolong for fruit ripening. Among four lines only one line (TR9) showed 5-6 days different in ripening compared to non DR papaya or other three lines of DR papaya. TR9 DR papaya ripened in 10 days and 8 days compared to 4 days and 3 days on non DR papaya, at room and AC temperature respectively (Damayati *et al.* 2007). Ethylene production analysis showed that ethylene in TR9 DR papaya was lower than non DR papaya (Damayati *et al.* 2007).

2. Seed-less (parhenocarpy) crop

Parthenocarpy, or fruit development in the absence of fertilization, has been genetically engineered in various plants like eggplant, tobacco, tomato, and raspberry using the *DefH9-iaaM* gene (Acciarri *et al*. 2002, Rotino *et al*. 1997, 2005, Carmi *et al*. 2003, Mezzetti *et al*. 2004). The *iaaM* gene codes for tryptophan monoxygenase and confers auxin synthesis, while the *DefH9* controlling regions drive expression of the gene specifically in the ovules and placenta (Rotino *et al*. 1997). Transgenic *DefH9-iaaM* crops show increased fruit production due mainly to an improved fruit set. However, the weight of the fruits is also frequently increased (Acciarri *et al*. 2002, Rotino *et al*. 2005, Carmi *et al*. 2003, Mezzetti *et al*. 2004). GE parthenocarpic eggplants and tomatoes with the *DefH9-RI-iaaM* gene have been evaluated for improved fruit productivity under both greenhouse and open field trials (Acciarri *et al*. 2002, Rotino *et al*. 2005).

Research on the devopment of parthenocarpy tomato was conducted by Purnamaningsih (2005) from ICABIOGRAD. The genes of *defH9-iaaM* and *defH9-RI-iaaM* were transformed into tomato genome varieties of Opal and Ratna by using vector *A. tumefaciens* (Purnamaningsih 2005). T3 generation were grown in the biosafety containment greenhouse at ICABIOGRAD for selection and agronomic characters evaluation.

3. Free amylose content

Starch from potato and cassava contains about 20% amylose and 80% amylopectin (Smith *et al*. 1997). Granule-bound starch synthase (GBSS) is one of the key enzymes in the biosynthesis of starch and catalyses the formation of amylose. The antisense GBSS genes, based on the full-length GBSS cDNA driven by the 35S CaMV promoter or the potato GBSS promoter, were introduced into the potato genome by *A. tumefaciens*-mediated transformation (Fulton *et al*. 2002). Another transgenic amylose-free sweet potato has also been obtained by introduction of GBSSI (Kimura *et al.* 2004). Other two transgenic amylose-free wheat and cassava were also genetically engineered using GBSSI gene (Baga *et al.* 1999, Vetten 2004).

Inverted repeat cassava GBSS cDNA and *pat* genes were transferred into cassava genome Adhira4 (Indonesian variety) through *A. tumefaciens* mediated transformation by research team at AVEBE in Wegeningen, Holland (Vetten 2004). Five transformants of GE cassava had below 3% amylose content and 46 transformants had 3-10% amylose (Vetten 2004). The GE cassava was tested and selected in biosafety containment facilities, screen house, and confined field trials at both ICABIOGRAD and RCB LIPI (Herman *et al.* 2007).

Molecular Breeding in Crop Improvement

The use of molecular marker for crop improvement consisting of mining of new alleles and genes for biotic and abiotic stresses, transferring of trait(s) from wild or agronomically inferior donor source which is called "prebreeding" or "germplasm enhancement" and marker assisted selection. These are very important steps to follow for systematic crop improvement. Varietal improvement needs available diverse genetic variation as source of economically important traits such as resistance to pests and diseases as well as tolerance environmental stresses.

In last decades molecular marker has shown its potential for genetic diversity characterization and crop improvement. The use of molecular marker for crop improvement could help solve conventional breeding unsolved persistent problems, which, mostly selection of promising lines were based on phenotypic expression. While in molecular breeding, the selection processes were also based on the phenotypic expression and at the same time the needed alleles or loci may directly be indentified.

Research progress at the center (Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development) is in accordance with the advancing of the technology itself, thanks to the networking that we've been involved through the international research collaboration in several different research projects. The following are the results of research conducted at the center.

DNA finger printing analyses of food crops varieties

In 2004, variety identification has been done using fluorescence labelled SSR markers (*simple sequence repeat*) on 96 accessions of food crops such as rice, sweet potato and soybean (Septiningsih *et al.* 2004). With the use of DNA Genetic Analyzer, obtained fragment simay be acurately read. This is an important feature of variety

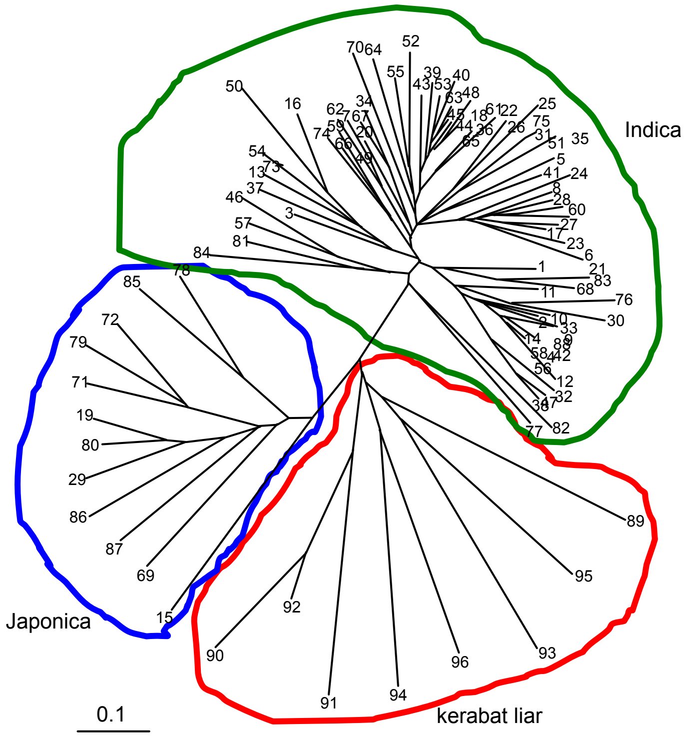

Figure 1. Dendogram of 96 rice accession anaylized using 30 SSR markers clustered into 3: wild relative, Japonica and indica.

identification for plant variety registration. Results indicated that almost all of rice accession have unique DNA finger printing. Rare alleles (with the frequency <5%) may have future use in varietal improvement. Grouping of rice accessions on the basis of the size of allele shown in Figure 1. Genetic variability parameter of 96 rice accessions analyzed with 30 SSR markers were presented in Table 2.

Three hundreds and five alleles ranges from 4-22 per locus were detected. In addition, alleles specific for each cluster or combination of two ro more clusters were detected. This allele specificity would be very useful in determining SSR marker for certain population of a cross. The average of gene diversity is 0.612 PIC value (*polymorphism information content*) is 0.581.

Similarly genetic analysis for sweet potato using 10 SSR markers indicated that among 96 accessions there is no relationships between accession and their origin, except those accessions collected from Papua, where those from Wamena were in different cluster from that of those from Manokwari (Figure 2). This may be due to different genetic reources and geographic isolation, which widen the genetic distance. This indicates higher genetic

Table 2. Genetic variability parameter of 96 rice accessions analyzed with 30 SSR markers.

Panel	Marker	Allele size (bp)	Major allele frequency	No. of allele	Gene diversity	Heterozygousity	PIC
1	RM5	108-132	0.351	9	0.773	0.043	0.741
1	RM433	212-228	0.810	4	0.325	0.022	0.300
1	RM55	201-243	0.637	11	0.564	0.042	0.538
1	RM215	127-157	0.474	12	0.690	0.042	0.650
1	RM514	246-272	0.411	8	0.727	0.042	0.686
2	RM214	88-158	0.768	15	0.405	0.011	0.399
2	RM11	122-146	0.453	9	0.740	0.021	0.715
2	RM144	160-277	0.527	14	0.665	0.043	0.632
2	RM237	115-151	0.536	12	0.657	0.052	0.624
2	RM171	321-345	0.533	6	0.645	0.011	0.602
3	RM133	227-233	0.489	4	0.557	0.053	0.459
3	RM287	83-117	0.272	12	0.828	0.011	0.808
3	RM259	145-177	0.447	12	0.721	0.021	0.687
3	RM250	138-178	0.734	16	0.450	0.032	0.439
3	RM507	224-260	0.811	5	0.322	0.021	0.294
4	RM161	143-179	0.806	10	0.343	0.000	0.334
4	RM283	95-167	0.718	9	0.462	0.021	0.439
4	RM124	259-297	0.441	7	0.649	0.022	0.582
4	RM162	189-241	0.495	13	0.676	0.000	0.636
4	RM277	106-126	0.704	6	0.471	0.011	0.437
5	RM431	241-265	0.478	9	0.701	0.000	0.666
5	RM154	100-226	0.266	22	0.863	0.011	0.851
5	RM484	292-310	0.810	5	0.323	0.000	0.296
5	RM105	89-137	0.525	7	0.656	0.013	0.616
5	RM536	226-266	0.458	10	0.712	0.011	0.677
6	RM125	104-149	0.760	8	0.403	0.039	0.379
6	RM19	194-260	0.380	9	0.782	0.013	0.757
6	RM541	104-192	0.560	14	0.653	0.011	0.631
6	RM413	76-182	0.321	10	0.784	0.000	0.752
6	RM474	228-280	0.313	17	0.819	0.016	0.799
	Mean	165.4-211.7	0.543	10.2	0.612	0.021	0.581

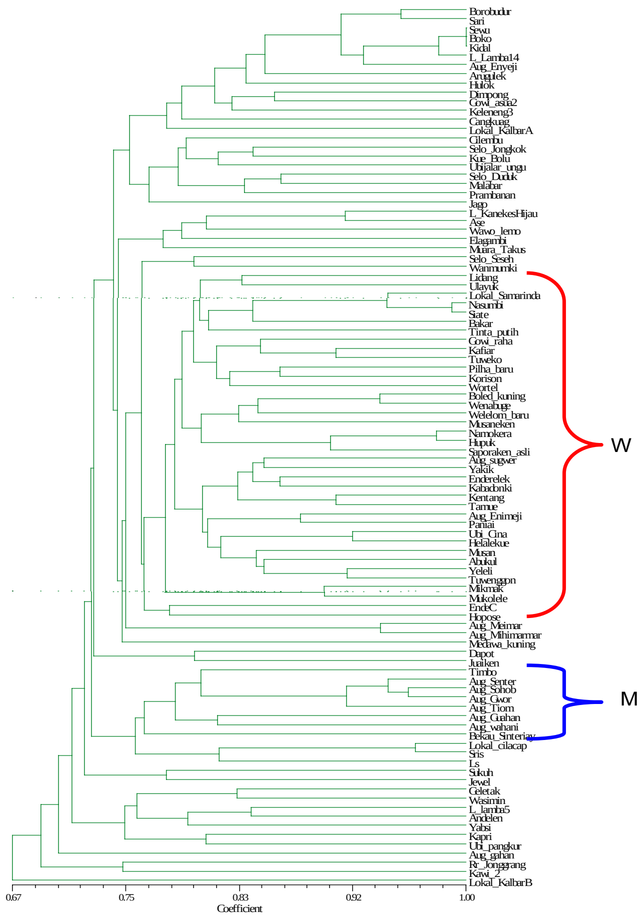

Figure 2. Dendrogram of 96 accessions of sweet potato analyzed using 10 SSR markers.

variability of those found in Papua which molecularly support the status of Papua as the secondary center of diversity of the world sweet potato.

Heterozygousity level indicated by high genetic variability ranging 0.51 (IB275) to 0.99 (IB255F1) with the avarage of 0.81 (Table 3).

For soybean, results of molecular analysis of 96 soybean accession using 10 SSR markers found 116 alleles ranges from 7-19 alleles per locus with the PIC 0.703 (Figure 3). Improved varieties tended to cluster together which indicated their relatedness. It was also found genetic difference between two accessions with different accession number and names. On the other hands there were also accessions with different accession number and names but the same genetic identity.

So far, characters used for plant variety protection are pigmentation and other morphological characters. However, current commercial soybean varieties developed from

Table 3. Number and size of alleles, and heterozygousity level detected on 96 accessions of sweet potato using 10 SSR markers.

Panel no.	Primer	No. of allele	Range of allele size	Heterozygousity level
1	IB286	8	88-106	0,932
1	IB316	6	128-146	0,614
1	ASUS P 3	14	158-206	0,953
2	IB318	20	66-177	0,966
2	IB248	18	82-272	0,939
2	IB255F1	15	216-298	0,988
3	ASUS P 12	11	75-113	0,933
3	AUS P 16	10	86-123	0,655
4	IB275	16	87-261	0,511
4	ASUS P7	53	65-385	0,597
Mean		17,1		0,81

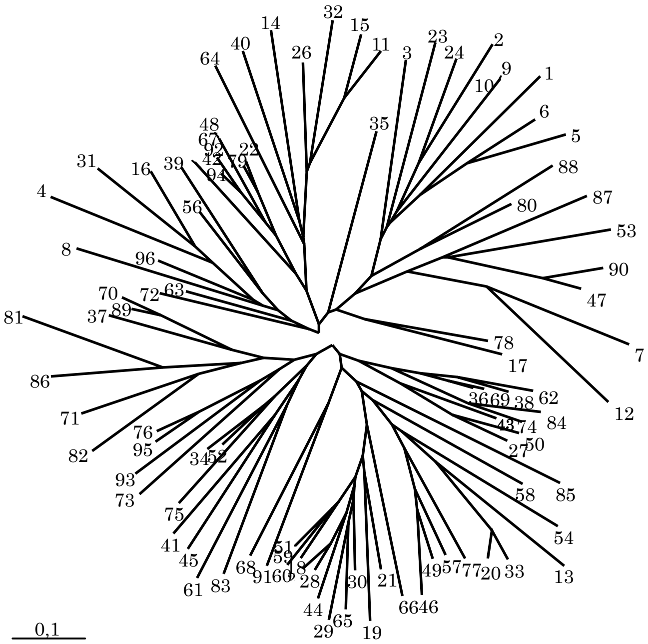

Figure 3. Dendogram developed using PowerMarker of 96 soybean accessions analyzed by 10 SSR markers.

elite lines which is very limited, which, therefore, it is very dificult to differenciate them if not impossible on the basis of those characters. In this situation the use of molecular marker could be very helpful. Size, number and frequency of major alleles, heterozygousity, gene diversity, and polymorphisme level of 96 soybean accession identified by 10 SSR markers were presented in Table 4.

Table 4. Size, number and frequency of major alleles, heterozygousity, gene diversity, and polymorphisme level of 96 soybean accession identified by 10 SSR markers.

Panel	SSR marker	Allele size (bp)	No. of allele	Major allele frequency	Heterozygousity	Gene diversity	PIC
1	SATT308	118-172	12	0,3421	0,0316	0,7998	0,7757
1	SATT038	157-191	10	0,3263	0,0000	0,8211	0,8014
1	SATT114	79-107	7	0,4740	0,0104	0,6181	0,5460
1	SATT242	103-160	10	0,4375	0,1250	0,6603	0,5971
2	SATT147	190-326	12	0,6421	0,0421	0,5573	0,5317
2	SATT243	261-295	11	0,2708	0,0000	0,8105	0,7846
2	SATT414	268-314	13	0,4239	0,0000	0,7481	0,7203
2	SATT294	253-300	14	0,5000	0,0100	0,7061	0,6830
3	SATT009	142-245	19	0,2500	0,0104	0,8629	0,8494
3	SATT177	105-117	8	0,3177	0,0208	0,7746	0,7405
Mean		167,6-222,7	11,6	0,3984	0,0251	0,7359	0,7030

Mapping and QTL analysis of aluminum tolerance in rice

Research on mapping and Qtl analysis of alluminum tolerance in rice was conducted by Moeljopawiro *et al*. (2003). Abiotic stress is one of the most important problems in sustaining food security in Indonesia. The only possible extention of production area is toward marginal land, which, mostly dominated by red yellow podsolic that is subject to low pH, Al, Mn, and Fe toxicities, and poor in N and P. In order to solve those problems, the most economical solution is to breed rice varieties tolerant to acidic soils, which, therefore, reduce the high cost need for liming.

Tolerance to alluminum toxicity is quantitatively controlled trait which make difficult to phenotypicaly sellect the tolerant onces due to complex gene interaction controlling this trait. In addition, environmetal effect makes it more difficult selection. Therefore, the use of molecular marker is recomended.

Mapping of genes for tolerance to aluminum toxicity was started in 2004 by developing F2 population of Dupa x ITA131 cross. One hundred and ten SSR primers were used to develop linkage map as shown in Figure 4. Fourty eight markers (72.73%) follow Mendellian law of inheritance (1 : 2 : 1) while 18 markers (27.27%) do not which indicated that 18 loci do not freely segregate and half of it dominated by ITA131 genotype (aa). Results of QTL analysis for markers linked to tolerance to aluminum toxicity shown in Figure 5.

Figure 5 shows potential of QTL for Al tolerance with LOD value of 2.03 on chromosome 2. Whereas on chromosome 9 the LOD value is very low, indicated that there is no relationship between Al tolerance and SSR marker.

Development of durable blast resistant lines using wild relative of rice

Research activities on the development of durable blast resistant lines using wild relative of rice was conducted by Dwinita *et al*. (2007). *Oryza rufipogon* is one of wild species of rice known to have importance genes for rice improvement program. In order to

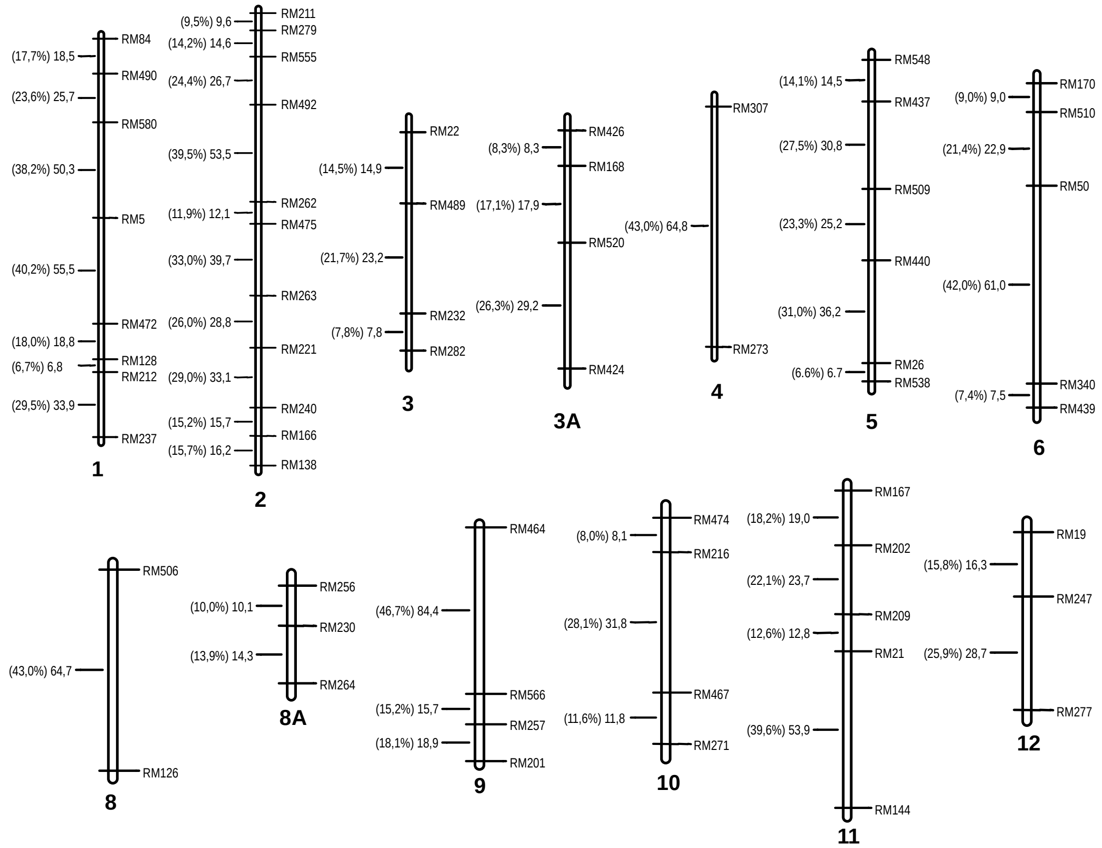

Figure 4. Linkage map of 66 SSR primers on 94 individual of F2 (Dupa x ITA131). Percentage (%) indicates recombination frequency followed by marker distance (cM) and primer.

utilize those genes, has been developed BC5 population as well as double haploid population of IR64 x *O. rufipogon* Cross. These two populations were then used to map blast resistance genes and to develop durable promising blast resistant lines. This was the research collaboration with CIRAD with the objectives: (1) to identify blast resistance genes, *Pir4*(t) from *O. rufipogon* and *Pir7*(t) from IR64, on chromosome 2 and (2) to evaluate durable blast resistance of double haploid lines derived from BC_2F_3 of IR64 x *O. rufipogon*. To detect the accurate locus of the target gene, fine map was to be developed. Two lines of BC5 population: 317-25-1-6 and 317-25-1-3, with the introgression level needed, were used to develop fine map and to identify the target genes. TO complete and to enhance candidate gene analysis on the target position, the *insilico* strategic analysis on *fragment region peak* target between RM263-RM250 markers were used. Twenty five putative genes were found on this *fragment region.* These putative genes were then analyzed and the selected gen were further sequenced their bases to design specific primer based on TIGR *gene genome browser*. These designed primers were *Single Nucleotide Polymorphism* (SNP) primers which have high polymorphism level that can be used to enhance fine map development.

Figure 6 shows better interval mapping on BC5F2 population with the highest LOD value of 17.1 as compared to that on BC2F3 population which has LOD only 3.59. GLM analysis fo the association test indicated significance between PiSNP4 primer, located on 110.9 cM and blast isolate ID31 having *avr2* allele (*CM28*) at *avr gen* locus, other ACE1 primer was PiSNP7 with LOD value 7.3 significance to blast isolate ID9 that has *avr1* allele (PH14) at avr gen *ACE1* locus.

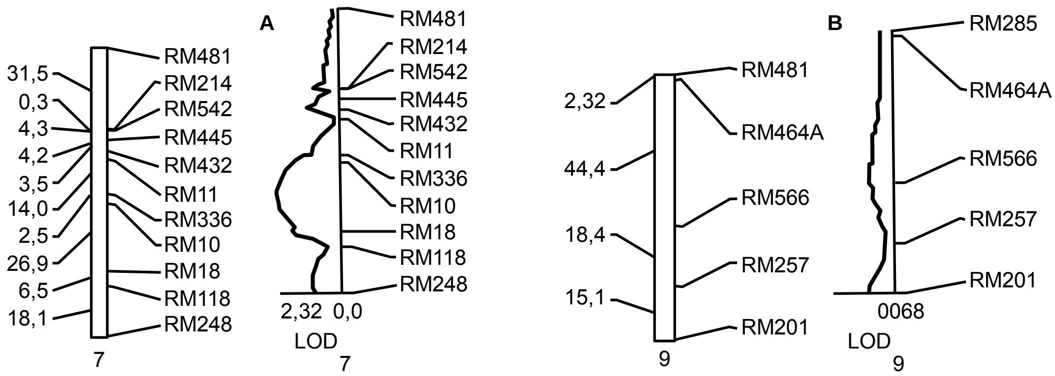

Figure 5. Linkage map of SSR primers of 190 individual F2 (Dupa x ITA131) on chromosome 7 (A) and chromosome 9 (B).

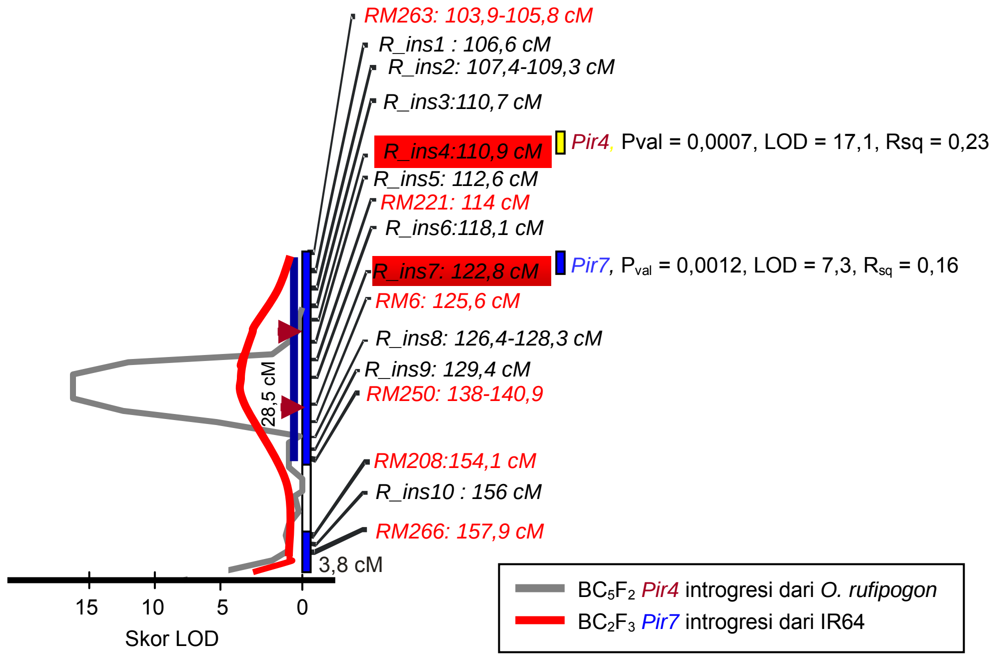

Figure 6. Interval mapping analysis (CIM) P*ir4* (introgression from *O. rufipogon*) and *Pir7* (introgression from IR64) of BC5 population compared to BC2 population.

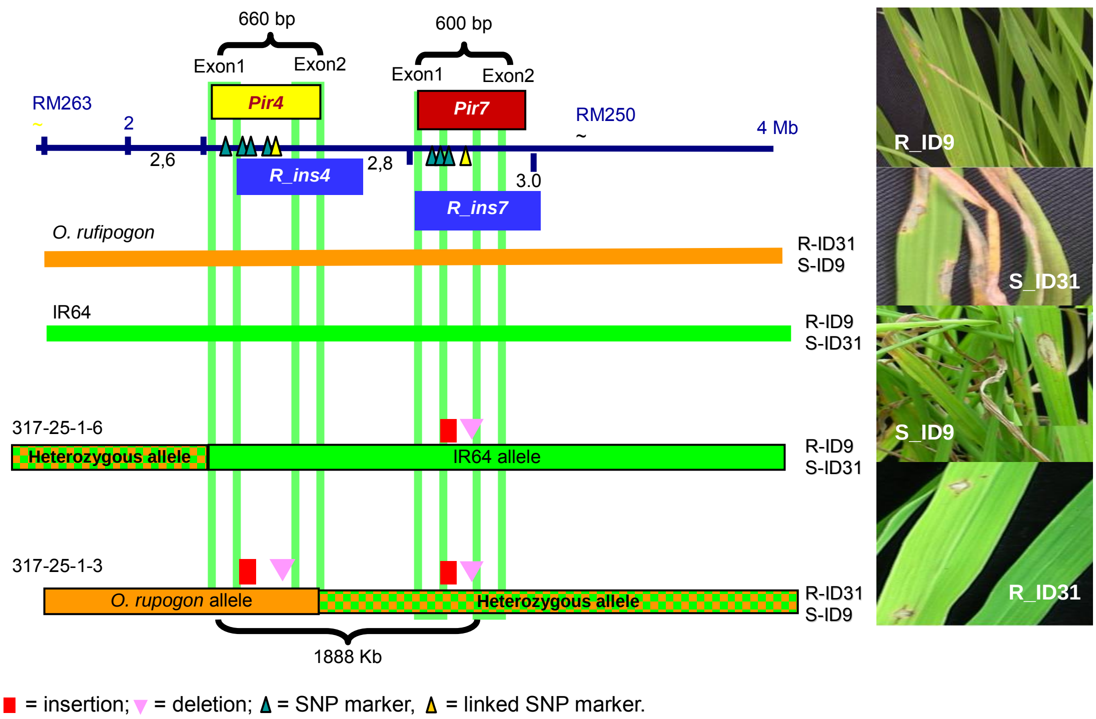

Figure 7. Position of genes *Pir4* (660 bp) linked with *SNP R_ins*4 marker and *Pir*7(600bp) linked with *SNP R_ins7* marker, and *progeny contrast* test of 317-25-1-6 (*Pir7*) and 317-25-1-3 (*Pir4*) lines.

Progeny contrast test for both target genes, as shown on Figure 7, indicated that IR64 resistant to blast isolate ID9 (*PH14*) but susceptible to ID31 isolate (*CM28*). Whereas the donor parent *O. rufipogon* resistant to ID31 isolate but susceptible to ID9 isolate. Introgression analysis of BC5F2 progeny indicated that NIL 317-25-1-6 which has introgression from IR64 on *Pir7* locus resistant to ID9 isolate. While NIL 317-25-1-3, which has introgression from *O. rufipogon* on Pir4 locus, resistant to ID31 isolate. Resistance response of those two BC5 lines similar to the response of both parents IR64 and *O. rufipogon*.

Marker aided selection for bacterial leaf blight resistance

Research activity on the marker aided selection for bacterial leaf blight resistance was conducted by Bustamam *et al*. (2002). In relation to the application of biotechnology in rice improvement program, Asian Rice Biotechnology Network has been established to solve rice production problem related to diseases. As a result of this network has been selected two lines, Bio-1 and Bio-2 were selected for their resistance to *xa5* and *Xa7*, respectively. Figure 8 and Figure 9 show the DNA profiles of BC5 F1 derived from IR64//IRBB5 and DNA profile of BC_5F_5 derived from IR64//IRBB7. In the phase III planning of ARBN in Indonesia 1999 it was decided to continue the network by conducting several research activities. One of the research activities to be held in Indonesia was three year program for the continuation

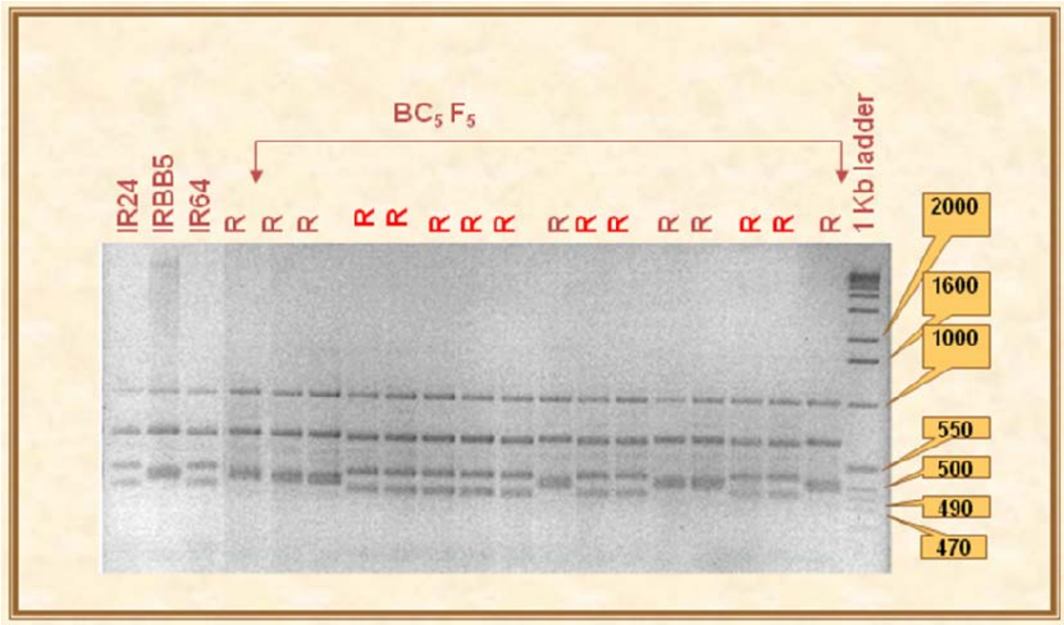

Figure 8. DNA profiles of the IR64//IRBB5 lines. DNA was amplified by STS primer *RG 556* and cut the PCR product with Dra1. The R indicated co-segregation allele xa-5 with R parent, IRBB5 at 500 bp.

of marker aided selection of rice resistant to bacterial leaf blight which includes: (a) Monitor the evolution of predominant pathotypes that can overcome major resistance genes (*xa5*, *Xa7*, *Xa21*) being used in the breeding program, and (b) Continue MAS to advance backross population of IR64 carrying *xa5* and *xa7*. This would be the necessary steps to follow since these two lines were the first lines in South East Asia selected through the use of molecular marker, that need to be thoroughly evaluated for their usefulness. These lines were then nationally released as new lowland rice varieties, Angke and Code which were named after the rivers' name in West Java and in Yogyakarta, respectively.

The Application of *In Vitro* Culture for Crops Improvement and Conservation

Farming efficiency can be developed through crop productivity improvement. One of the methods to increase productivity and quality of products is the improvement of plant materials, either in genetic or physiologic quality. The productivity improvement can be achieved through the plant genetic potential and increase in resistance to biotic and abiotic factors.

The above crop improvement can be done among others by means of biotechnology that has been proven to be able to overcome various constraints in production that cannot be solved conventionally. Considering the importance of utilizing biotechnology, which is capable of supporting the agricultural development program, research in *in vitro* culture (as one of the technologies in Biotechnology) has been conducted in the Balai Besar Biogen. The technology is directed towards several aspects, i.e., crop multiplication, conservation of

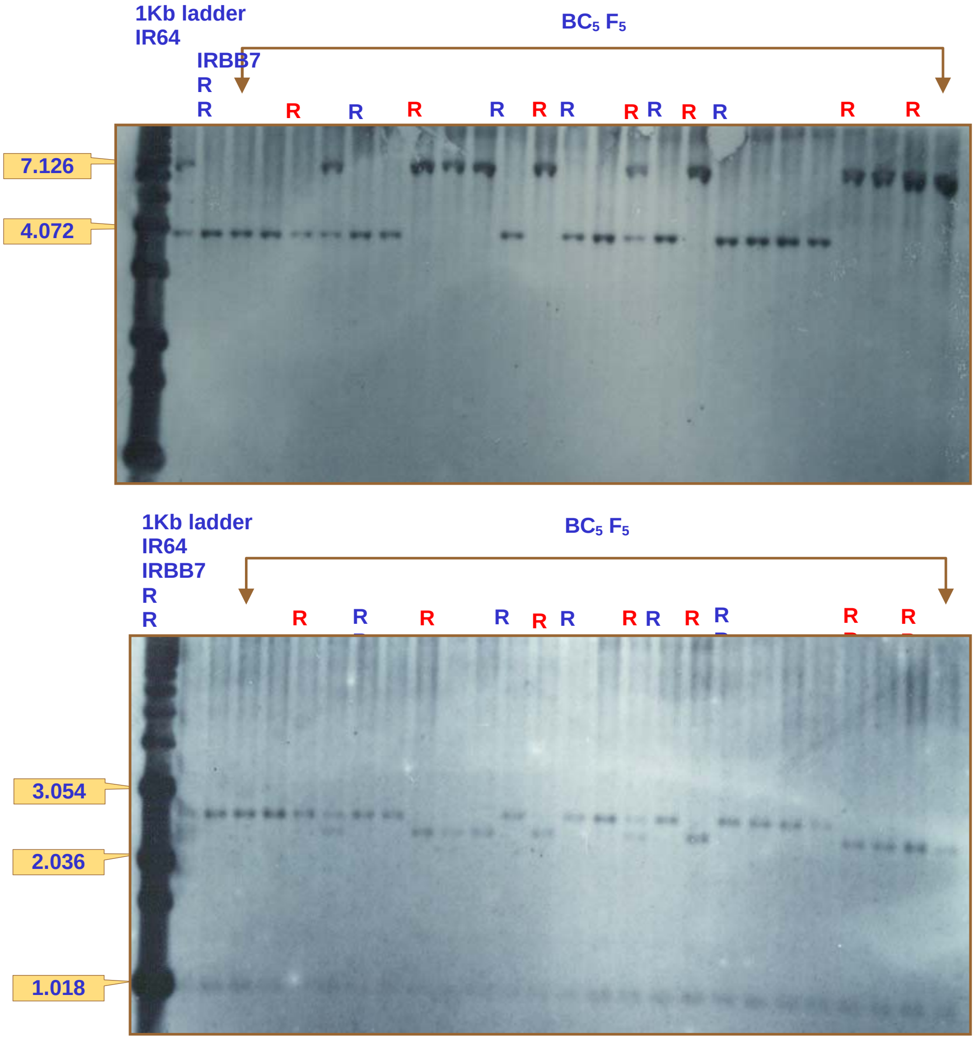

Figure 9. DNA profile of BC_5F_5 derived from IR64//IRBB7. The R progenies shows co-segregation with IRBB7, the R donor parent when hybridized with molecular marker G1091, DNAs were cut with restriction enzyme *Bam*HI (above) and *Bgl* II (below).

germplasm, plant genetic improvement, embryo rescue and secondary metabolite production (Mariska *et al*. 1989).

The genetic quality improvement is prioritized to those plants difficult to develop generatively. Such plants in general have low genetic variance. Plant improvement through *in vitro* culture is expected to be able to result in new properties (characteristics) found in the existing gen pool. In the early phase, the research is aimed to improve the genetic variance so that from the population resulted it can be utilized by breeders in order to produce new varieties. The method use among others is by means of protoplast fusion (eggplant and patchouly), somaclonal variation (vanilla and patchouly), *in vitro* selection (vanilla, abaca, rice, and soybean), embryo rescue (vanilla and mungbean) and anther culture (rice and corn) (Mariska *et al*. 1994).

Conservation of germplasm by means of *in vitro* is applied to potential endangered medicinal plants as well as several other industrial crops. Endangered medicinal plants generally do not produce seeds. To conserve such plants, they are cultivated in collection gardens conventionally, with high risk of losing the plant species, particularly due to diseases and severe climate (drought and others). *In vitro* storage by means of minimal growth has been conducted on plant parts or in living tissue conducted in laboratory. Failure of this method can be minimized since the storage condition can be controlled (Mariska and Gati 1996).

Crops improvement

The researches in *in vitro* culture that have been conducted among others are plant improvement through somaclonal variation, anther culture, protoplast fusion, embryo rescue of those resulted from crossing among species, as well as the conservation of industrial crops particularly the endangered medicinal plants. As previously stated, the number and variance of industrial, horticultural and medicinal plants are significant. Therefore, researches are conducted based on priority (emergency needs) and upon request of or in collaboration with third party.

This research was conducted for the plants of pepper, vanilla, ginger, soybean, rice, corn, banana, abaca, and burley tobacco. The problems faced in the development of those plants were mainly diseases, i.e., foot-root in pepper (*Phytophthora capsii*), bacterial wilt in ginger (*Pseudomonas solanacearum*), stem-root in vanilla, abaca and banana (*Fusarium oxysporum*). Aside from the diseases, drought and acid land were other problems in the plant development. The use of resistant varieties is one of the very effective and efficient methods in overcoming the problems. So far the source of resistance to diseases has not been found, except for the foot-root disease for pepper.

Accordingly, the researches conducted in the beginning were principally aimed to the increase of genetic variation through somaclonal variation (ginger, vanilla and patchouly), *in vitro* selection (vanilla, rice, abaca, banana and soybean), anther culture (burley tobacco and corn), embryo rescue of among species crossing results (vanilla and mungbean) and protoplast fusion (pepper and vanilla).

A. Somaclonal variation

1. Ginger, patchouli, and vanilla

   The *in vitro* selection and somaclonal variation can be used to support the plant improvement program. Through this method, the genetic diversity can be upgraded and even the new characteristics resulted cannot be found in the existing gene pool.

   To increase the genetic variation, shoot in ginger, callus in patchouly as well as globular structure in vanilla were irradiated using gamma ray, and then multiplied using *in vitro* method. Callus and shoot used had experienced relatively long *in vitro* period (2-4 years).

Even ginger could grow on irradiation dose of 0.50-1.50 krad. However, plantlet irradiated with an intensity of 1.50 krad generally grew rudimentary and dead after sub-culture, while irradiation with intensity of 0.50 krad resulted in cultivar growth not differently from the control (no variation). Cultivar radiated with intensity of 1 krad resulted in variation in leaf color, i.e., turning into white or albino (15%), greenish white (5%) and green (52%). White plantlet (chimera) was dead after sub-cultured, while the greenish white leave color turned back into green after sub-cultured.

After transplanted in the field, the variation of the growth component was not significantly different from the control. However, after tested on its resistance to wilt disease, the level of resistance variation was slightly increased. Testing results in greenhouse showed six numbers tolerant to *Ralstonia solanacearum* T.586 and afterwards they were retested either in laboratory or field. From the results, the increase in variation through irradiation on shoot experiencing long *in vitro* culture was hopefully could be applied in the ginger breeding program.

Different response occurred in patchouly toward every dose of radiation of each different callus age. The increase in irradiation dose on callus experiencing long culture period resulted in decreasing its regeneration capacity. The result of callus regeneration indicated either different appearance or variation in oil content. From the variances resulted, there were around 23 numbers which had oil content higher than that of the mother plant. The oil content of the mother plant or control varied from 2 to 3% and the oil content of the plant resulted from callus regeneration combined with physical mutagen varied from 1 to 4%. The facts implied that the opportunity to increase genetic variation through tissue culture was sufficiently open (Mariska *et al*. 1996a, Nagatomi 1996).

In vanilla, the irradiation was conducted on callus and globular structure. After being acclimatized in a greenhouse and the plantlet grown multiplied conventionally, there was an indication of variation in growth characteristics and morphology of the leaves. Results of the resistance test on *F. oxysporum f*. sp. vanillae strain F-17 of the radiated plantlet indicated that there were three numbers with no symptom of disease after being inoculated. *In vitro* selection and somaclonal variation can shortened the breeding cycle and obtains disease resistance particularly for annual crops (Mariska *et al*. 1996b).

2. Artemisia (*Artemisia annua L.*)

Malaria disease is a very dangerous one. Case in malaria disease is growing to increase from time to time. A number of research results indicated that some malaria parasites such as *Plasmodium falciparum* (cause of tropical malaria) had been resistant to malaria medicine currently used. *Artemisia annua L*. is a potential plant to be developed as anti-malaria medicine. So far the raw material of Artemisia is imported from abroad since the domestic production is still under-qualified. This is due to the fact that high yield clone of Artemisia able to produce high artemisinin compound (≥ 0.5%) has not been found yet. One of the efforts to obtain the required raw material is to find the clones of Artemisia plant having high artemisinin content and large adaptation capacity. A mutative induction was used in the research concerning the Artemisia using gamma ray and somaclonal variation to increase plant genetic variation from explant, callus shoot (bud). From the research results of 2007, several strains of Artemisia somaclones were obtained. Some of the strains had been acclimatized and planted in experiment field Gunung Putri. Some strains indicated different morphology from their mother plant and then the content of artemisinin compound was analyzed.

3. Rice

Paddy '*Fatmawati*' is classified as new type with lots of superiority but its empty husk production is still high has low resistance to blast disease. For that reason, mutation with gamma ray on callus was conducted in order that the variation increased.

Callus irradiated with 1000-1500 rad doses had been successfully regenerated in order to produce plantlet. The plantlet of each treatment was acclimatized in a greenhouse using Yoshida solution and had produced rough rice.

The plant number resulting grains over 100 kernels per panicle was selected and then inoculated using three races of blast (001, 033, and 073) in order to obtain a plant with resistance to leaf blast. From the 256 numbers tested, about 21 numbers were found to be resistant to the three races of blast. The numbers resistant to leaf blast were also expected to be resistant to neck blast.

B. *In vitro* selection

1. Vanilla

In vitro selection is aimed to improve certain characteristics, e.g., resistance to disease and environmental pressure. This method has been successfully applied to many plants; among others was the *in vitro* selection on vanilla plant for improving the resistance to *F. oxysporum*. The research was conducted with the selection on the levels of cell and colony cell from the filtrate of *F. oxysporum* and *Fusaric Acid* used as the selection component. The laboratory research results indicated the correlation between the resistance to selection component and the resistance to *F. oxysporum* (Mariska 1997).

2. Soybean

The *in vitro* selection on soybean plant was conducted in order to find new expected numbers which were resistant to acid land and drought. The new numbers could be used by breeders to assemble new high yielded varieties. Callus from zygotic embryo was irradiated using gamma ray with a dose of 400 rad and then selected with Al and low pH for tolerance to acid land, and was selected with PEG for tolerance to drought. Selection with Al was at several levels of concentration from 0 to

500 ppm and for PEG from 0 to 30%. After selection, the cell mass was regenerated through somatic embryogenesis. For the resistance to acid land, plant (somaclone) resulted from the selection treatment was tested in four locations up to the sixth generation to show the existence of high potential for obtaining somaclone (potential plants) tolerant to acid land. And so was for the tolerance to drought with the existence of new numbers of potential already tested in a greenhouse. Besides, the prolin content from the somaclone was higher compared to that of the control.

3. Rice

In vitro selection in rice was conducted to find new potential numbers resistant to drought. Callus inducted from zygotic embryo was irradiated with doses ranged from 0 to 2000 rad or mutated with EMS (Ethyl Methane Sulfanase) with concentrations ranged from 0 to 50 mM at pH = 2 by means of submerging for 3 h. The mass of the callus was selected with PEG 0-30% and after that it was regenerated and the plantlet was tested in a greenhouse with PEG, root penetration capacity, prolin content and draught. The test results indicated the new potential numbers having high capacity of root penetration on paraffin and vaselin layers in the pot base, resistant to PEG as well as its prolin content higher than that of the control. Besides, the potential numbers had higher productivity than their mother plant although they were planted in stress condition.

C. Anther culture

1. Rice

One of the alternative procedures suggested in new variety assembling is by initially making pure strain through spontaneous doubled haploid/dihaploid induction of individual or by means of multiplying chromosome from haploid individual. In rice plant, the haploid induction through anther culture is the simplest method and easy to do, compared to pollen culture and ovary culture. The characteristic of doubled haploid plant is constantly stable from generation to generation, so that the selection can be conducted directly on the initial generation. Research on anther culture in rice plant has been routines since the finding of the procedure and media composition suitable to apply on laboratory condition at BB-Biogen. Through anther culture, a number of strains of dry-land paddy resistant to canopy or tolerant to aluminum was obtained. In the on-going research on hybrid rice, the anther culture was also used to accelerate the gaining of sterile male strain candidate and fertility recovering agent.

2. Maize

As previously explained, the use of dihaploid plant is one of the alternatives that can shorten breeding time in order to find pure strain or it can be used to find new hybrid. The use of new hybrid has been proven to be an effective method to increase corn productivity. To obtain pure strain, it took time of eight to ten generations; through anther culture followed by multiplication of chromosome, however, it took only one generation of plant. For that reason, the anther culture of corn plant has been conducted since 2005. Anther at mid or late stadium-uninucleate had been cultured on various formulated media, starting from Yupei through N6 and given with amino acid, sucrose, as well as the growth regulation substance like auxine and cytokinine. The results cannot be presented since the research is still ongoing; media formulation and other physical factor capable of inducting embryogenic callus and its regeneration are still being searched.

D. Culture and protoplast fusion

1. Pepper and Eggplant

The culture and protoplast fusion of pepper and eggplant was aimed to transfer the characteristics of resistance to disease of the wild pepper to cultivated pepper. The research comprised several phases, i.e., protoplast isolation, hybridization, regeneration of hybrid cell, and testing of hybrid characteristics.

So far the results obtained was isolation method, protoplast fusion, and green colored callus. Effective protoplast isolation was that using cellulase enzyme R-10 solution and macero-enzyme R-10 of 2% and 5% for pepper, respectively; and 2% and 1% vanilla, respectively, for 90 minutes with 83 rpm centrifuging; protoplast fusion was done using PEG 25-30% solution. The protoplast resulted from the fusion had been able to form green callus seen in the solid medium surface of agarose and ready for regeneration (Mariska *et al*. 1993).

Eggplant (*Solanum melongena*) is one of the important horticultural commodities in the tropic area with warm weather. One of the constraints in producing eggplants is the bacterial wilt disease (*Ralstonia solanacearum*), nematode (*Melaidogyne* sp.) and fungus (*Fusarium oxyporum f.* sp. *melongenis*). The source of resistance exists in its wild plant like *Solanum aethiopicum*. The resistance characteristic was often failed to transfer to cultivated plant through conventional hybridization due to uncompatibility or the F1 resulted is sterile. To overcome the problems, protoplast fusion was conducted followed by anther culture from its somatic hybrid and back-crossing of between mother plant and haploid plant. The protoplast fusion between S. *khasionum* and S. *aethiopicum* was conducted using PEG 50% for 20 minutes. Before fusion, protoplast isolation with protease and cellulase mixture was conducted.

The plant resulted from the fusion had been characterized and indicated that chromosome from both parents existed in all hybrids. Aside from that, its somatic hybrid was more resistant to bacterial wilt, and so was the haploid plant. So far 1^{st} back-cross has been conducted with its fruit structure resembling to that of the cultivated parent plant but with resistance similar to its wild plant.

2. Citrus

The main objectives of the citrus cession breeding programs in Indonesia are: enlargement of the ripening season (earlier and later ripening cultivars), seedlessness, easy peeling, high rind color, low tendency to alternate bearing, good flavor, better standardization of the fruit (shape and size), of the fruit chemical composition and of its post-harvest behavior and resistance to the most dangerous pests and disease.

The somatic hybridization techniques is very important for creating new scion citrus (easy-peeling, seedless, pigmented, high quality and high productivity) from Mandarin citrus/Satsuma (seedless, easy-peeling, and pigmented) to Siam citrus (local variety). The somatic hybridization technique was conducted in the fusion of two protoplasts, one originated from embryogenic callus (Siam) and the other from leaf-messophyll (Satsuma). The fusion was made through the use of the polyethylene glycol (PEG) 4 and 5%. For the regenerated after fusion, VKM medium (liquid) was very good for the regenerated to cell wall, microcalli and initiation buds from callus of solid medium. The goal was to release new citrus variety by somatic hybridization with easy-peeling, seedless, pigmented, high quality and high productivity.

E. Embryo rescue

1. Vanilla

The embryo rescue was aimed to transfer good characteristic from wild vanilla to cultivated vanilla crossed reciprocally between the cultivated vanilla (*V. planifolia*) and wild vanilla (*V. albida*) from several locations, i.e., Ciamis, Garut, and Sukabumi. Tissue culture was used to rescue the embryos resulted from crossing. Temporary results indicated that hybrid seed could germinate in the media of MS ½ + BA 1 mg/L. The seeds resulted from crossing could germinate if cultured at the age of 2-4 months after pollination. Outside from the age range the embryo could not grow. For cultivated vanilla seeds, at all levels up to eight months after pollination the seeds could grow. And so was for the wild vanilla.

2. Mungbean

Cross of mungbean (*Vigna radiata* (L.) Wilczek) with its wild plant, black bean (*V. mungo* (L.) Hepper), was aimed to transfer the characteristic of resistance to scab disease of the wild plant. For that purpose, the black bean to cross was selected from accessions having high resistance to that disease.

Three accessions with high resistance (VR-34, VR-35, No 19/1) were chosen from the selection and were expected to fit with *Walet* variety mungbean. The crossing result indicated that VR-35 was the most suited for crossing with Walet variety with best seed quality and germination. The seed F1 was germinated in the media of MS + BA 1 mg/L. The number of chromosome of this seed F1 was also multiplied by culturing it in the media of MS + Kolkisin. Multiplication of chromosome number was seen on the seed cultured in the media of MS + BA 1 mg/L + kolkisin 0.15% for two days.

Conservation

Not all of various cultivars resulted from plant multiplication researches were acclimatized. Every species (particularly for vegetatively multiplied plants) that has been multiplied is stored alive or in growing condition. Especially for endangered medicinal plants, minimal growth conservation method has been applied since the last three or four years.

The in growing storage method has time limitation so that sub-culture has to be conducted very often. High frequency sub-culture can increase the risk of contamination, more intensive labor requirement and the properties of the seeds resulted can change.

The endangered medicinal plants the conservation of which had been tried by means of minimal growth storage method were pulasari, pule pandak, inggu and purwoceng. Retardant like ABA (1-10 mg/L), paclobutrazol and ancymidol (0.50-5.0 mg/L) were used to decrease the growth rate. The growth rate of pule pandak cultivar stored in a media of MS + ABA (1 mg/L) for 15 months did not decrease. Media that could decrease the growth rate of pulasari cultivar was MS½ + paclobutrazol (5 mg/L) (Mariska and Gati 1996). Purwoceng cultivar had shown a slow growth rate even without retardant.

For purwoceng plant, cultivar could be stored for 10 months by means of minimum growth technique using media of DKW + BA (1 ppm) + 2.5% sucrose. Cryo-preservation technique with vitrification method for purwoceng plant was also conducted with 40% of successfulness level (Roostika *et al*. 2007).

The minimal growth and cryopreservation techniques had also been applied to tubers like sweet potato, cassava, yam, taro, black potato and gembili. Using the minimal growth technique, sweet potato plant could be stored for 18 months in the media of KNOP & Heller + paclobutrazol (5 ppm) + 6.5-10% sucrose. Cassava could be stored for 10 months in the media of MS + 4% manitol. Black potato could be stored for 12 months in the media of ¼ MS without sucrose. Taro could be stored for 31 months in the media of MS at low temperature. Yam could be stored for 12 months in the media of MS + ancymidol (3 ppm). Gembili could be stored for 6 months in the media of MS + 4% manitol (Roostika and Sunarlim 2001, Roostika *et al*. 2004a, 2004b, Roostika *et al*. 2005, Sunarlim and Roostika 2003, Sunarlim *et al*. 1999, 2004).

In cryopreservation technique, the vitrification method was proven to be better than that of encapsulation vitrification although the successfulness level was still low. And so with cassava, the vitrification technique had been successfully applied with 50% successfulness level (Roostika *et al*. 2004c, Megia *et al*. 2007).

Conclusions

Genetic improvement is conducted in order to increase genetic variation through somaclonal variation (ginger, patchouly and vanilla), culture and protoplast fusion (pepper and eggplant), embryo rescue (vanilla and mungbean) as well as *in vitro* (vanilla, rice, soybean, abaca and banana). Research results indicate that ginger, *patchouly* and vanilla plants show variation on various characteristics, among others is morphology (vanilla), resistance (ginger and vanilla) and oil content (patchouly). The protoplast fusion between eggplant and its wild plant has resulted in new hybrid resistant to bacterial withering disease, and so is its dihaploid plant. Through anther culture and back crossing with its cultivated parent plant, new genotype has been obtained which is resistant to wilt disease and has agronomic character similar to its cultivated parent plant.

The *in vitro* selection of rice, soybean, banana and abaca has resulted in new potential numbers resistant to *Fusarium oxysporum* (vanilla, abaca and banana), drought (rice and soybean) and acid land (soybean).

Vanilla seed resulted from crossing between V. *planifolia* and V. *albida* has been able to germinate to form plantlets; and the hybrids formed needs to be tested of its resistance to disease.

The development of new line through anther culture has resulted in a number of dry-land rice strain resistant to canopy (shade) and tolerant to aluminum. For corn anther, formulation of media and other physical factors capable of accelerating embryogenic callus induction and its regeneration are still being searched.

The cultivars stored through tissue culture in general can be maintained for 1-6 years with sub-culture (culture renewal cycle) for 3-4 months. By adding growth retardant substance to cultivars, the renewal cycle could be extended. In Rauvolfia plant, the cultivar could be stored for 15 months (without renewal) if ABA 1 mg/L is added to the cultivar media. And so is with *purwoceng*, adding of sucrose or manitol could store it without sub-culture for more than 7 months and incubated in low temperature.

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The Conservation and Management of Animal Genetic Resources in Indonesia

Bambang Setiadi[1] and Kusuma Diwyanto[2]

[1]*Indonesian Research Institute for Animal Production, Ciawi-Bogor, Indonesia*
E-mail: b_setiadi@telkom.net

[2]*Indonesian Centre for Animal Research and Development, Bogor, Indonesia*
E-mail: kd_267@yahoo.com

Introduction

The management of animal genetic resources (AnGR) can be defined as an effort for conservation and sustainable utilizing of genetic resources for eternal human prosperity. The AnGR is a realization of the convention on biological diversity particularly for genetic materials of animals or livestock containing the functional unit of heredity. The use of animal genetic resources for human interest includes all information related to the genetic expression having a particular economic value such as the characteristics and processes of the animal genetic that last in living creatures. The genetic resources are then regarded to have both real and potential specific values. These animal genetic resources are used commonly for foodstuff, clothing, drought power, fertilizer, bio-fuel and other human basic needs. Therefore, the management, conservation, access, and handling of AnGR should be considered.

The utilization of AnGR has developed into diversity of genetic materials such as different animal breed and or strain, derived from local and exotic, as well as inhabitants. The AnGR has also been applied directly and indirectly through the breeding process. From direct utilization, AnGR can also be made as a reverse genetic conformity to buffer the unsatisfactory environment and economic changes.

The human needs for food and animal products are continuously increasing, that brings the availability of AnGR is becoming very important.farmers and animal breeders are then motivated to create new animal breeds or strains with better quality and higher value. During the 1930's to 40's, most scientific genetic selection of animals was carried out in Europe and the USA. The application of their technologies in the improvement of animal breeding programme has made possible to an unprecedented rate of increase in the production of food and fiber per animal. Few animal breeds with high performance have been developed and gradually substituted the local animal breeds in temperate regions. As a result, there has been a growing concern that the latter may disappear altogether unless special efforts are made to conserve the local breeds (FAO 1984).

Indonesia and other developing countries are concerned with their own livestock resources, especially when the introduction of many high-yielding breeds from the temperate zones. This may lead to a decreasing number of local breeds. The latter has, through natural and man-made selections, developed characteristics which are well adapted to their living environment, where oftenly harshing the environmental conditions. This valuable genetic material needs to be maintained and improved as the basis for the national livestock breeding programmes and policies.

Indonesia with her mega-biodiversity must have supporting technologies in utilizing the genetic resources. For that reason, it is necessary to establish research collaboration between Indonesia and other countries which have advanced technologies through profitable access policy. The policy should protect the existence of genetic resources as the national asset in future.

In relation to the issues of AnGR excessive exploration, some problems are faced for the conservation and use of genetic resources as well as materials transfer in obtaining AnGR. Regarding to the existance of AnGR and the country sovereignity and/or AnGR ownership, either individual or public, the access problems are related to the ownership of resources while the profit shares are related to the use of genetic resources.

The access problem of genetic resources was initially discussed since the agreement of biological diversity convention in 1992. As a consequence, the Government of Republic of Indonesia ractified the United Nations Convention on Biological Diversity (UN-CBD) under Law Number 5 in 1994. In Section 1 of CBD, it is notified that the profit resulted from the genetic resources used should be fairly dan equally divided to the owners of the genetic resources. In general, accessing of genetic resources has been applied through collaboration networks among scientists, institutions, and countries, mostly for research purposes and non-commercial breeding. The collaboration network is working well without bureaucracy. But, the genetic resources are more often transferred illegally. Many genetic resources originated from Indonesia have been developed overseas without profit sharing to Indonesia as the owner.

There is a tendency in decreasing of local AnGR diversity due to competitiveness against certain animal breeds with high productivity. Science and technology should therefore be conducted without sacrificing the AnGR diversity, as we can still: (1) select an animal type adapting to the emergence of new disease, which is not pre-detected; (2) anticipate the change of environmental condition like climate change; or (3) develop new science and technology to handle the nutritional problems. We should maintain the AnGR diversity through various ways and policies for the sustainable food security and human prosperity of present and future generations.

Animal Role in Agricutural Sector

In poviding the protein requirement for human, more than 50% of total protein consumed is originated from livestock and fish. Currently, the animal products contribute between 30% and 40% of the global economy value for food and agriculture, and about 1.96 billion of human population depend directly on animal species.

Based on the data of IFPRI in 1995, Blackburn *et al.* (1998) projected the meat demand will increase from 2-6 million tones in 1990 to 275-310 million tones in 2020. During 1990 to 2020, the total development of meat, pork and chicken increase 101-170%; 131-225%; and 126-211%, respectively in developing countries and 11-14%; 12-16%; and 30-31%, respectively in developed countries. Meanwhile, milk demand increase increase more than 7% and 133% in developed and developing countries respectively.

Animals may provide most of organic fertilizers for the agricultural farming. Without organic fertilizer, the soil is usually less productive. The manure can also be used as source of energy for fuel (biogas) in certain community. The animals could also be used as draught animal power in agriculture or as transportation vehicles.

Animal products such as wool and fur are used for clothing, while skin is used for other purposes (shoes, belt, bag, etc). Furthermore, animal products may also be used for medicinal purposes in a certain community, which is generally having a cultural custom. As part of a traditional custom, the animals have an important added-value for agro-tourism in some countries of Southeast Asia, for example sheep fighting in West Java, bull race in Madura, and even as a real income source.

Animal production in developing countries also provides job opportunity and as family savings. The animal can be sold easily during harvest failure or long drought. Animal gives an important contribution in integrated agricultural system.

Consideration for Conservation of Animal Genetic Resources

Problems of the global AnGR were identified by FAO in 1980. The first is a decreasing in genetic variability within breeds. It is mainly a problem for high yielding breeds raised in temperate zones with intensive production systems. The second is a rapid disappearance of indigenous breeds through the indiscriminate introduction of exotic breeds. The third is regarding as a special problem of the environment such temperatures, humidity and other harsh environments commonly occur in developing counties. Only in restricted areas within these environments is possible to improve animal health protection measures as well as feeding and management practices to the levels that would allow high-yielding animals from the temperate zones to be raised. In these circumstances, it is important to design and apply an appropriate selective breeding programme based on existing populations which are adapted to harsh environments (FAO 1984). Some aspects that should be taken into consideration related to the diversity of AnGR are: (1) the lack of community awareness and different interpretation to maintain the diversity of AnGR; (2) the development of animal breeding programme; (3) the policy and or regulation that brings less support to maintain the diversity of AnGR; and (4) the economic reason.

The use of technology in animal breeding seems to be in inappropriate direction i.e. using some animals. “Top-Breeders” attempt to rapidly increase the quality of animal breed. The widely use of this technology may can cause negative impacts that can increase “in-breeding depression” and hence lower the productivity, fertility and adaptability of animals. The development of using primary animal furrow as a result of uncontrollable and massive utilize of high technology/modern biotechnology can push the depletion of genetic resouces diversity. The *genom* manipulation might still far left behind as compared to plant. According to Global Biodiversity Assessment (Heywood and Watson 1995), the modern agriculture system applying very latest technique and continuous monoculture has caused the negative impact toward agro-biodiversity, mainly in: (1) narrowing plant/animal genetic diversity, which is cultivated; (2) reduction the quality of local environment; and (3) damaging the natural ecosystem in the area (erosion, mudslide etc). Therefore, developing agriculture, which is environmentally friendly (eco-technology), is the thing that have to be done.

Breeding consideration, which prioritizing product standardization and productivity should not sacrifice the diversity of genetic resources. On the other hand, protecting the diversity of local genetic resource should not hinder the importation of animal for production by imposing castration for imported animal. Similarly in controlling the spreading of animal disease in certain area should not be done by stamping out the entire animals in the region. The policy issues should at least be the best alternative to conserve AnGR diversity.

The main key in the AnGR management is the difference of genetic value among species, breed, group and individual, that enable the producer to select the genes which may best suited to the desired goal for certain environment. The manipulation of genes within a species through selection, crossing or combination may bring the producer to achieve the desired goal if there is enough genetic diversity. If the goal changes due to the change of environment, the producer or breeder should have the access to the same resources of genetic diversity to adjust to the new goal.

The short cut to increase the animal productivity through the introduction of exotic breed from the temperate area and conducts random crossing may result in loosing genes, which in developing countries are not retractable. Therefore, the value of locally adapted breed would be of value. The crossing may be profitable, but without thorough evaluation by comparing with locally adapted breed it can cause the extinction of local breed. The objectives of genetic resouces management among other are:

- Conserve and develop an optimal use of genetic resouces optimally;
- Enrich the collection of genetic resouces by collecting from various sources including the collection from international origin;
- Protect the wealth of genetic resouces of Indonesia origin to prevent being patented by other countries or inappropriate used;
- Provide information, education and the genetic resouces material for the community;
- Provoke the community participation in the activity of conservation, protection and utilization of genetic resouces;
- Act as the base for forming the national gene bank for genetic resources;
- Develop national policy of genetic resouces management;
- Guarantee the diversity of genetic resouces for preventing threats to the national food security, and;
- Support and coordinate the genetic resources management in the country and cooperate with other countries.

So far there is no integrated national organization networking available yet, that is mutually handling genetic resources to realize the objectives of optimal management of genetic resouces. Exploration and exchange of genetic resouces are still handled by many institutions, but not through one door policy.

Various kinds of daily human needs are fulfilled by animal species as in the form of food and other needs. Only few of total diversity of animal genetic and its wild relatives, i.e. about 40 species, fulfill most proportion of global animal production. The genetic diversity within animal species and several wild relatives has become the diversity source from breed and animal population. This genetic diversity is important in the sustainable formation of modern animal breed from now on. The extinct of the diversity of animal genetic resouces will not be replaceable even through current biotechnology progress. Therefore, managing the existing diversity of genetic resouces, maintaining its productivity, and providing the increasing demand in relation to the increasing of population are challenging. On the other hand, human activity causes the erosion of animal genetic resouces diversity, for example replacing the local animal breed which is adapted to local environment with imported animal breed that is regarded as more productive, but needs higher inputs. By maintaining the local animal breed adapted to the environment with so many constraints, with low cost production system that, in general, can be obtained in the developing countries, would certainly improve the global long term food security. Besides, through the development of local animal breed, it is expected to be able to increase the income of farming due to the cultivation pattern used is still low-medium production input.

Global data bank for Farm Animal Genetic Resources reported by World Watch List for Domestic Animal Diversity (FAO 2000) show that there are 6,379 breeds from 30 species of mammals and avian. From these population, 1,335 breeds or 32% are classified as endangered/critical breed having high risk to extinct. These breeds have only less than 1,000 breeding females and less than 20 breeding males. Most of endangered breeds are found in the developing countries.

The genetic diversity also enables the animals to adapt against diseases, parasites, environmental, and some other factors. In the last few decades, some breeds of animal species have been successfully developed to increase the productivity by improving one or two production characteristics in the controlled condition. Those animals produce more meat, milk or eggs as long as they are in the favorable environment (feed, temperature, disease control, management).

With that level of productivity those animal breed have been exported to various countries in the world, with the hope that they will soon adapt and can be cultivated more efficiently. However, instead, those animal breed need more additional feed and other productions inputs to keep their productivity. Furthermore, those imported animal cannot reproduce or live as good as local animal breed adapted to its environment. As a result, the productivity cycle for their whole life of the imported animal, or even their generation crossed with local animal, produce less than the local animal that cause losses.

The main components for the implementation of sustainable conservation and utilization of AnGR are: (1) the mechanism among different sectors to make sure the involvement and continuous help and the policy suggestion from government; (2) the planning and implementation structure to support the network at the national, regional and global levels; (3) the technical work program, aiming at helping in managing AnGR at the national level; and (4) the monitoring and evaluation, which are the component to complement the basic data and information needed as guidelines, the reporting of diversity status of AnGR, as well as helping for the success of global strategy.

The preparation of National AnGR management plan is the key element for technical program work. AnGR management in a country technically is very complex where the participation of breeders and breeding staffs, policy maker, scientist, local and traditional communities, and involved individuals is needed. The national preparation will help the country for: making use the guidelines for sustainable animal development for important food and agricultural production; examining the need and priority; increasing the awareness of role and value of AnGR, including genetic resources that can adapt to local environment; target improvement and increasing the effectiveness of management activity cost; and, for the developing countries, being able to get fund from developed countries.

Follow-up Plan

The AnGR management system should be followed-up soon at national levels. Considering that this subject has been discussed for the last few years, whereas genetic erosion continuously occurred meanwhile the anxiety on loss of various Indonesian genetic resouces owned due to the languid handling, the following action plans are therefore need to be carried out:

- Encourage the related steakholders to finalize and enact the law on Conservation and Sustainable Used of Genetic Resources;
- Division of tasks among institutions and related parties to prepare various products needed for establishing the National Genetic Resources Management System;
- Socialization of the National Genetic Resources Management System;
- Discuss the formation of a national institution for the Conservation and Sustainable Use of Genetic Resources;
- Put in order the existing policies and strive for the formation of policy framework to support the management of the conservation and fair and sustainable utilization of biological resources;
- Restore the biological diversity in the conservation and priority production areas which have been degraded;
- Prevent the degradation level of habitat by re-planning the allocation of the layout and access to biological resources, and at the same time conserve as many as possible habitat and genetic resources to support the community welfare;
- Strengthen the network of biological diversity management with the realization of participative regional autonomy through the development of incentive system and compensation mechanism accross region;
- Strengthen the law enforcement in the fair and sustainable utilization and conservation of genetic resources;
- Develop education, research, training, and information system which support the fair and sustainable utilization and conservation of genetic resources;
- Develop the database, the monitoring system and inventory and the information exchange network (clearing house mechanism) for genetic resouces conservation which can be accessed by broad community;
- Develop and apply the technology that can increase the added-value of genetic resources in the management framework which is fair and sustainable by emphasizing precautionary approach and local creativity;

- Revitalization, strengthening and recovering the traditional law and institution supporting sustainable and just biological diversity management;
- Expand the international cooperation for the national genetic resouces management and conservation with emphasis on the partnership in the financing, benefit sharing and the transfer of effective technology.

Clossing Remark

The strength of AnGR depends on the diversity standard of elements which form them. Therefore, the AnGR conservation is to maintain the diversity of genetic resources. The conservation of genetic diversity will always be needed in breeding, because, without the genetic diversity, any breeding program will not be implementable.

There is a tendency that some genetic resoucess of local/native breed in Indonesia are experienced the extinct threat. The extinction of genetic resouces could have the short term and the long term effects. Therefore, understanding of sustainable of genetic resouces diversity management should be related to the nature and its possible future change which is believed that the genetic resouces will be very useful for human life.

The emerging of awareness on potential of AnGR and the problems related to its conservation and sustainable use could be the basis of the need for legal instruments. We are responsible for “the difficulty” faced by the future generation by letting the lost of AnGR diversity to occur. We should not neglect the important of the AnGR diversity of Indonesia due to the lack of understanding on their genetic potential, which we firmly belief that they are very usefull for our future.

Integrated genetic resouces management is utmost important due to the fact that currently AnGR are managed separately by several different institutions. Therefore, a coordinating body is needed with regard to further development on biosafety, alien species, tacsonomy, and benefir sharing.

AnGR conservation should not be regarded as opposed to regional income, which, on the other hand just and sustainable use of AnGAR will help conserving them. Conservation and and sustainable use of AnGAR are becoming global community concern, which, therefore, need to be fully understood in implementing the law of decentralization of the governance.

The conservation and the development of diversity of AnGR approaches could be done by implementing: (1) the precautionary approach; (2) the “polluter-pays-principles”; (3) encouragement of participatory breeding at farmer level; and (4) the support of diversification of animal business and their use in accordance with agro-ecosystem condition.

The diversity of AnGR is one of main factors in improving the food security. We have to maintain the diversity of animal as ancestor legacy, because the extinction of various breed of animal and the loss of traditional knowledge related to the management of agricultural diversity could cause a serious implication toward ecology and economy. The choice of science and technology for the future should not hamper the diversity of AnGR. By conserving the diversity, we can; (1) select the animal breed capable of resisting the new emerging disease; (2) anticipate the change of environmental condition; or (3) develop new science and technology to overcome the nutritional problems. Conservation of genetic resources in the form of gene bank, *in situ* and *ex situ* including coordination of information network should be prioritized. We have the obligation to maintain the agricultural diversity for sustainability and prosperity of human welfare at the present and future generations.

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The Importance of Research Program on Genetic Diversity of Wildlife for Their Conservation

Machmud Thohari

Department of Forest Resource Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University, Indonesia; Research Center for Bioresources and Biotechnology, Bogor Agricultural University, Indonesia; and National Committee on Genetic Resources, Bogor, Indonesia
E-mail: mthohari@yahoo.co.id

Introduction

Indonesia is one of the mega-biodiversity countries, which has at least 47 distinct natural ecosystems (Sastrapradja *et al*. 1989), ranging from the ice fields and alpine meadows of Papua to a wide variety of humid lowland forests, from a deep lakes to shallow swamps, and from spectacular coral reefs to sea-grass beds and mangrove swamps (M0F/FAO 1991 *in* KMNLH 1993). The species diversity is very high, covering wild plant and animal species. There are at minimum about 11% of the world's known flowering plant species, 12% of the world's mammals, 15% of the world's amphibians and reptiles, 17% of all birds and at least 37% of the world's fish (KMNLH 1993). In general, the larger the population size of a species the greater its genetic diversity, and the less likely it is to go extinct. Unfortunately that this may be hard to detect the genetic diversity of those wildlife species.

A number of Indonesian species are widely distributed and occupy a range of different habitats, often involving adaptation to local conditions reflected in different genetic make-up between the various populations. Examples include plants such as Pometia pinnata, Bambusa vulgaris and Syzygium moluccanum, and wild animals like *Colocalia fuciphaga, Placeus manyar* and *Geopelea striata* (KMNLH 1993).

There are at least three biological reasons to believe that genetics can be the basis of an important and critical area of conservation biology. First, the Fundamental Theorem of Natural Selection (Fisher 1930 *in* Meffe *et al*. 1994) told us that the rate of evolutionary change in a population is proportional to the amount of genetic diversity available. When genetic diversity in a population decreases, the rate and scope of potential evolutionary change in the population in response to environmental challenges is reduced. Essentially, loss of genetic diversiy reduces future evolutionary options. Second, there is consensus among population geneticists that heterozigosity, or high genetic variation within populations, is positively related to fitness. Heterozigosity at a single or multiple gene loci (single-locus and multi-locus heterozigosity, respectively) may confer fitness advantages upon individuals. Reduced individual heterozigosity may lead to lower fitness. Loss of such diversity will likely decrease the ability of organisms to respond to environmental change, and will also discard biological information potentially useful to humans, such as crop genetic diversity or valuable biochemicals. In essence, we are losing the "blueprints" of life.

The basic problem linking genetics to conservation is that small populations, whether in the wild or in captivity, tend to lose genetic variation over time. This loss of variation may well increase the probability of population extinction or reduce opportunities for future adaptation through evolutionary change. Because habitat fragmentation and destruction will continue to produce small, isolated populations of plants and animals, and because by the time many species are recognized as threatened or endangered, they are, almost by definition, in small and isolated population, understanding the genetic consequences is vital to good management and recovery efforts. The basic thrust of conservation genetics, the message to take from this chapter, is to maintain genetic diversity and thus preserve options for future evolution.

Population Diversity

Within species, interpopulational differences are quite variable, they depend on the species reproductive biology, environmental diversity, and specific traits or gene examined. Obviously, each species has evolved a survival mechanism, but genetic variations may lie primarily within populations with little interpopulational differentiation, or primarily between isolated populations with less intrapopulational variability. The management implications of these species structures for preserving natural diversity need to be drawn (Namkoong 1983).

It may be quite common for a species to expand rapidly from normally small, isolated populations, into large, interbreeding epidemic populations with trancient homogeneity. This is true for some forest tree species and some insects that change behavior in the transition from endemic to epidemic populations (Namkoong *et al*. 1979 *in* Namkoong 1983). This phenomenon may be true for vertebrate as well. If a species exist within genetic divergence among populations, whether connected by migration or not, then the differences may be due to selective differences or to cryptic mating barriers, which allow alleles to diverge in frequency. The divergence rarely can be ascribed solely to one the other mechanisms, it would be useful to know if the genetic variations are responses to selection pressures or are merely superficial artifacts of no evolutionary consequence. If they are superficial, and if all loci have similar evolutionary trivial variations, or if any important genetic effects are share commonly through all populations, then any single randomly chosen population could preserve significant diversity as well as any other. In such cases, the species' diversity is continued within the populational the differences either are trancient or are maintained by limitation on migration.

If divergence among populations exists at any of the loci due to selective effects of the environment, then the population diversity reflects an important feature of the species' evolutionary capacities. It may be presumed that individual homeostasis, and indeed single populational homeostasis, is insufficient for adaptation to the ecological diversity that a species experiences. Hence, management of diversity may require multiple populations. Very low migration rates among populations are sufficient to maintain alleles in the separate populations unless strongly selected against.

It may sometimes be necessary or unavoidable to allow differences to go to extremes such that alleles, possible different, are fixed in each population. At one extreme, nearly all loci may be forced to fixation while those that arre critical for survival and have heterotic effects remain polymorphic. Adaptation to severe inbreeding may be required for survival and may even be enhanced. While this may not be feasible for many, the fixation of alternate alleles maximizes most measures of diversity and, as long as populations persist, the genetic polymorphism is protected at the species level. Thus, subdividing a species into population that differ in allele frequencies and fixations can be an effective may for managers to protect genetic diversity. Since many species naturally exist in separate, environmentally distinct patches, examination of the population might be done under these conditions.

Genetic Variation

Lewontin (1974) *in* Beardmore (1983) stated that the advent of electrophoretic and refined immunological techniques over the last twenty years or so has led to a massive increase in knowledge of the gene polls of a great variety of life forms. The basic feature uncovered by these studies is that most species posses very large amounts of genetic variation; that is, there are highly polymorphic at many loci. The loci surveyed in such cases may not be random with respect to the genome. Most of the genes examined are structural loci, the work of Powell (1979) *in* Beardmore (1983) shows that regulatory loci also display polymorphism.

Typically a species will have about 25% of its loci polymorphic and the average heterozigosity of an individual will be about 7%, though such figures conceal considerable variations, as the data for a range of life forms (Table 1) reveal. Nevo (1978) stated based on his analysis on the work of others, that invertebrates have higher levels of heterozigosity on average than do vertebrates, plants being intermediate. Tropical species posses more genetic variation than do temperate or cosmopolitan species, and habitat generalists more

Table 1. Mean levels of polymorphism (P) and heterozigosity (H) in a range of life form[1] (Beardmore 1983).

Group	Species	P	H	Number of individuals sampled
Vascular plants	*Lycopodium lucidulum* (shining clubmoss)	0.10	0.060	241
	Phlox drummondii (drummond's phlox)	0.19	0.040	100
Invertebrates	*Phoronopsis viridis* (Phoronid "worms")	0.26	0.088	120
	Limulus plyphemus (horseshoe crab)	0.25	0.057	64
	Euphausia superba (krill)	0.14	0.058	127
	Drosophila pseudoobscura ("fruit" fly)	0.42	0.123	1265
Vertebrates	*Pleuronectes platessa* (European plaice, a flounder)	0.26	0.102	2270
	Mus musculus (house mouse)	0.26	0.085	99
	Mirounga leonine (Southern elephant seal)	0.28	0.028	42
	Macaca fuscata) (Japanese macaque)	0.10	0.014	1002

[1] Mainly from Nevo (1978).

Table 2. Comparisons of mean values for heterozygosity (H) in different groups of organisms[1] (Beardmore 1983).

Lower genetic variation	H	Number of species	Higher genetic variation	H	Number of species
Vertebrates	0.049	135	Plants	0.071	93
Cosmopolitan	0.048		Invertebrates	0.112	
Temperate	0.066	168	Tropical	0.109	45
Habitat specialists	0.046	120	Habitat generalist	0.106	117

[1] Data from Nevo (1978)

Table 3. Genetic Variation Expressed as Average Heterozygosity (H) for Different Groups of Habitat Specialist and Habitat Generalists[1] (Beardmore 1983).

Habitat type	Plants		Invertebrates		Vertebrates		Overall	
	H	No	H	No	H	No	H	No
Specialist	0.04	2	0.06	33	0.04	82	0.05	117
Generalists	0.08	12	0.15	54	0.07	56	0.11	122

[1] No = number of species. All four habitat comparisons are highly significant (Nevo 1978).

than habitat specialists (Tables 2 and 3). Mainland populations also tend to show higher levels of genetic variation than do island populations of the same species, though the sample sizes are small and the differences not always statistically significant. Finally, the values for polymorphism and heterozigosity generally are highly significantly correlated.

Loss of Genetic Variation

If genetic variation is important to fitness and adaptive change, then it loss should be of serious concern to conservationists. The central problems in conservation genetics are loss of genetic diversity in small populations and change in distribution of this diversity among populations. Loss of diversity can result in reduce evolutionary flexibility and decline in fitness, either from expression of deleterious recessive alleles or loss pf over dominance. Change in the distribution of diversity can destroy local adaptations or break up coadapted gene complexes (outbreeding expression). Both problems can lead to a poorer “match” of the organism to its environment, reducing individual fitness and increasing the probability of population or species extinction. A major concern of conservation biologist at the population level should be to maintain as much natural genetic variation as possible, in as near a natural geographic distribution as possible, so that evolutionary and ecological processes may be allowed to continue. To do this we need to understand how genetic variation is lost, both within and among populations. Reduced genetic diversity within populations may arise from four factors that are a function of population size: founder effects, demographic bottlenecks, genetic drift, and the effect of inbreeding (Meffe *et al*. 1994).

There are several closely related mechanisms by which small populations lose genetic diversity. First, a founder effect occurs when a few individuals establish a new population, the genetic constitution of which depends upon the genetic of the founders. If the founders are not representative of the parent population, or if only a few founders are involved, then the newly established population is a biased representation of the larger gene pool from which it came, and may have lower overall genetic diversity. Second, a demographic bottleneck occurs when a population experiences a severe, temperature reduction in size. One result is that the genetic variability of all subsequent generations is contained in the few individuals that survive the bottleneck and reproduce, the same fenomenon that occurs in the founder effect. Some genetic variability will be lost in the process, the magnitude of the loss depending on the size of the bottleneck and the growth rate of the population afterward. Third, genetic drift is a random change in gene frequencies in small populations, attributable to sampling error. That is, in small populations by chance alone some alleles will not be “sampled” or represented in the next generation.

Mathematically, genetic drift simply represents a chronic bottleneck that results in repeated loss of variability and eventual fixation of loci (loss of alleles). Fourth, inbreeding or mating, of individuals related by common ancestry, is a serious problem whose probability of occurrence increases in smaller populations if mating occurs at random (i.e., if mating with relatives is not actively avoided). Empirically, there is no absolute measure of inbreeding; the level of inbreeding is measured relative to a base population. The expected increase of inbreeding per generation, ΔF, is expressed, once again, as $1/2N_e$ if panmixia prevails. Inbreeding result in a predictable increase in homozigosity, and may be manifested in inbreeding depression, such as reduction in fecundity, offspring size, growth, or survivorship, changes in age at maturity, and physical deformities (Falconer 1981 in Meffe *et al*. 1994). Data from domesticated animals indicate that a ΔF of 10% will result in a 5-10% decline in individual reproductive traits such as clutch size or survival rates; in aggregate, total reproductive attributes may decline by 25% (Frankel and Soule 1981 *in* Meffe *et al*. 1994).

Not all inbreeding in cause for alarm. Many natural populations have apparently experienced low levels of inbreeding for many generations with no ill effects. In these cases, it is thought that slow inbreeding has given selection an opportunity to purge the population of deleterious recessive alleles. Rapid inbreeding, however, can be damaging to a population, especially if it has little history of prior inbreeding. Inbreeding depression may therefore be more prevalent in a species or population with historically large population sies that now occurs in small populations, than in historically small populations.

Small and isolated population, which describes many threatened and endanger species, will lose some percentage of their original genetic diversity over time, approximately at the rate of $1/2N_e$ per generation. A population of 1,000 will retain 99.95% of its genetic diversity (assuming lack of selection) in a generation, while population of 50 will retain only 99.0%. Such losses of diversity may seem small, but are magnified over many generations. After 20 generations, the population of 1,000 will still retain over 99% of its original variation, but the population of 50 will retain less than 82%. Small populations over a prolonged period are tthose to be avoided in conservation programs whenever possible. Thios is particularly evident in captive breeding programs.

Loss of among-population genetic diversity occurs when historically divergent and isolated populations experience an artificially high rate of gene flow with other populations through human action. This would typically occur when plants or animals are moved, intentionally or inadvertently, by people, or when new movement corridors are created. The uniqueness of formerly isolated populations may then be diminished or lost, as may their local adaptations and coadapted gene complexes.

Researches on Genetic Diversity of Wildlife

There are many research results carried out already on genetic diversity of several wildlife species in the world including in Indonesia. Some of those researches are as follows:

- Mitochondrial DNA D-Loop area, was done on wild green cock (*Gallus varius*), *cacatua goffini* (Finsch), kuskus (*Spilocuscus maculates*), rusa timor (*Cervus timorensis*).

- Cross-species amplification of 18 microsatellite markers in the Sumatran tiger (*Panthera tigris sumatrae*).
- Population structure based on genetic variation, was done on anoa (*Bubalus* sp.).
- Genetic variability and geographic structure, was done on three subspecies of tigers (*Panthera tigris*) based on MHC class variation.
- Phylogeography and genetic ancestry, was done on tigers (*Panthera tigris*).
- Genetic polymorphism using electrophoresis, was done on timor deer (*Cervus timorensis*), sambar (*Cervus unicolor*), bawean deer (*Axis kuhli*), babi rusa (*Babyrousa babyrussa*) dan wildboar (*Sus scrof*a Linn), Sumatran elephants (*Elephas maximus sumatranus*), long tailed macaque (*Macaca fascicularis*), Bali mynah (*Leucopsar rotchildi*), kelawat gibbon (*Hylobates muelleri*), kukang (*Nycticebus coucang*), kuskus (*Spilocuscus maculatus*)*, Rattus* spp.,
- Non-invasive DNA sampling and PCR amplified polymorphic, was done on Wild Gibbons' Parentage.
- Cytogenetic analysis, was done on wild red cocks (*Gallus gallus*) and wild green cocks (*Gallus varius*), orang utan (*Pongo pigmaeus* and *P. abelli*), *Rattus* spp.
- Mitokondrial DNA analysis, was done on orang utan, tapir, *minke whales* (*Balaenoptera acutorostrata*), bison*,* pronghorn antelope, North American river otters (*Lontra canadensis*), river otter scat.
- DNA markers analysis for golden eagle, dorcas gazelle, goshawk, *Addax nasomaculatus*, hamadryas baboons.
- Polymorphic microsatellite loci for North American river otters (*Lontra canadensis*), black-capped vireo (*Vireo atricapillus*), wild and domestic turkeys (*Meleagris gallopavo*), fishers (*Martes pennanti*), eastern phoebes (*Sayornis phoebe*), raccoons (Procyon lotor), eastern chipmunks (*Tamias striatus*), mule and black-tailed deer (*Odocoileus hemionus*), California bighorn sheep (*Ovis canadensis californiana*), rodent species (*Tamias striatus* and *Peromyscus leucopus*), allegheny woodrats (*Neotoma magister*),
- Ecological genetics, was done on mountain lions, black bears, yellow-billed magpies.
- Population genetic, was done on feral pig, red-tailed hawks, great gray owls,
- Genetic diversity using RAPD marker, was done on four *Intsia bijuga* populations, *Santalum album, Eusideroxylon zwageri,* Rafflesia (*Rafflesiaceae*).

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Agrobiodiversity and Rural Community in Indonesia

Setijati D. Sastrapradja[1] and Anida Haryatmo[2]

[1]*NATURINDO (Naturae Indonesiana), Bogor, Indonesia*
E-mail: dinkopib@indo.net.id

[2]*KEHATI Foundation, Jakarta, Indonesia*
E-mail: anida@kehati.or.id

Introduction

Long before the end of the World War II conservation of charismatic plants and animals had been the concern of not only the scientists but also the general public in the industrialized countries. Hence, the establishment of botanic gardens and zoos to maintain high aesthetic species of plants, such as *Raflessia*, *Ravenalla, Bombax,* and rare anilmals, such as rhinos, elephants and panda is utmost important. Such gardens and zoos are now in existence even in developing countries which were once under the colony of the industrialized countries.

The United Nations Convention on Biological Diversity (1992) has stimulated the wide spread of awareness on the loss of biological diversity not only among the scientific community, but also among the general public, as well as the politicians. The global community has been able to raise and mobilize fund to enhance conservation of the wealth of biological diversity which are valuable for the life of human beings. Therefore targets are set for 2010 to measure the success of the global efforts in conserving plants, animals, and the ecosystems they are in.

Indonesia is classified as one of the countries which are rich in biological resources. Moreover, Indonesia has exploited such a wealth for her national development. Natural forests have been tapped in large scale for their valuable timbers since late 1960 and followed by the harvest of marine resources in late 1980. Realizing the rapid decline of her biological diversity Indonesia has joined others in trying to slow down the rate of the loss (UU RI 1994). National strategy and action plan for biological diversity management were formulated to guide all actors of national development (BAP 1993, IBSAP 2003) in using the existing biological resources. However, guidance alone is not enough to reduce the rate of the biological diversity loss. Only concrete actions with the necessary funding to save the group of biological diversity which are directly valuable to human population could do the job.

Indonesia proclaimed her independence in 1945. Since then food security has become one of the many problems Indonesia has faced. It was true that in 1983 self sufficiency in rice was achieved, but Indonesia slipped back to her position as a rice importing country till today. Though Indonesia is rich in biological diversity, in which biological resources which are the raw materials for agriculture in general and food in particular are imbedded within, the fact remains the same that food insecurity is tailing us. This is due to, among others, the rate of population growth.

Of the 220 millions Indonesian population (BPS 2005), fifty percent live in rural area. Most of them are traditional farmers whose livelihood depends on biological diversity.

Various farming systems have developed in accordance with the natural set up and the crops that can be grown. For national food security, in which rice is the number one staple for Indonesia, modern uniform rice farming has been applied. On the contrary, traditional agriculture with the diversity of crops in a piece of land is still practiced in many types of farming systems. This diversity contributes to local food security.

Rice is no doubt will remain to be the most important staple food for Indonesia. Yet, many crops and breeds are valuable for local food security. Closely linked with these crops and breeds are plants, animals and microbes which help them to be productive. Together they form agrobiodiversity. The role of these natural occurring plants, animals and microbes in the production system has not been fully acknowledged. This paper presents the agrobiodiversity of Indonesia, its role in rural food security, its place in the changing Indonesia, and the possible role that scientific community can play to keep agrobiodiversity alive.

Agrobiodiversity: A Special Group of Biodiversity

In early 1986 a forum of BioDiversity was held in Washington DC. Based on this forum a book on Biodiversity was published (Wilson 1988). Since then the word has been used in political as well as scientific fora. With the Convention on Biological Diversity (1992) the global community refers biodiversity as “the variety among living organisms from all sources including *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (Convention on Biological Diversity 1992). In short there are three levels of diversity, i.e., at the ecosystem, the species, and within the species level. Biodiversity is vital for the life support of human beings. Hence, there are three main objectives of the convention, i.e., the conservation, the sustainable utilization and the sharing of benefits which derived from the utilization of biodiversity. The three objectives should not be regarded as independent elements but one entity.

Agrobiodiversity is a subset of biological diversity. Qualset *et al.* (1995) have defined agrobiodiversity as all crops and livestock and their wild relatives, and all interacting species of pollinators, symbionts, pests, predators, and competitors. The term used by Thrupp (1998) for agrobiodiversity is “the components of biodiversity that feed and nurture people-whether derived from genetic resources of plants, animals, fish, or forests”. Moreover, the knowledge for managing biological diversity of crops, trees, soils, animals, insects, and biota for food production is included in the definition. Wood and Lenne (1999) exclude wild plants and animals of food value outside the agroecosystems. Further, Wood and Lenne refer “agroecosystem” as “an ecological and socioeconomic system, comprising domesticated plants and/or animals and the people who husband them, intended for the purpose of producing food, fiber, or other agricultural products”. Hence, a great range of organisms above and below ground that can help or harm agriculture are included in the term. In this paper, medicinal plants are included in agrobiodiversity since they are component of special farming practices in Indonesia.

Following the above definition, agrobiodiversity is broader in scope than genetic resources as defined in Global Biodiversity Assessment (Heywood 1993). If genetic resources covers not only current varieties of crops and breeds but also their wild relatives which are valuable for future crops and breeds, agrobiodiversity include pests and diseases of crops and breeds as well. In other words, any organisms which are directly involved in the agricultural production is considered element of agrobiodiversity regardless of whether or not they are useful for improving crops or breeds.

As early as 1960s several scientists noted the erosion of crop genetic resources in their centers of diversity (Hodgkin 1986). Since then reports on various aspects of crop genetic resources activities have increased in number. It has been generally agreed that primitive cultivars and their wild relatives need more attention than the rest of the group in crop genetic resources. Introduction of advanced cultivars in farmers' fields has pushed aside primitive cultivars, while land conversion from wilderness to other development functions has degraded the habitats of the wild relatives of crops. Hence the need to conserve crop genetic resources has stimulated cooperation between countries in the United Nations family (1972). The establishment of International Board on Plant Genetic Resources by FAO and CGIAR in 1974 marked the beginning of the systematic global efforts in collecting and conserving crop genetic resources. It initiated the regional program in S.E. Asia through the establishment of RECSEA (Regional Cooperation in S.E. Asia (1976). In Indonesia a National Committee on Genetic Resources was initiated by the Department of Agriculture almost at the same time (Sastrapradja 2003).

Important as it is the conservation of plant genetic resources has mainly attracted the attention of those who work in crops or their related species, but not policy makers in general. Moreover, at the global level research institutes under the Consultative Group of International Agricultural Research Biological (CGIAR) genetic have the responsibility to manage genetic resources of the mandated crops. In this way, only a number of countries, especially in developing world, are really active in plant genetic resources activities. The Convention on Biological Diversity, on the contrary, has involved a wider audience than crop genetic resources. Moreover, the Global Environment Facility acts as the funding mechanism for the implementation of the convention. This mechanism support developing countries to fulfill part of their commitment to conserving their biodiversity. Only recently the plant genetic resources community has succeeded in establishing a Global Crop Diversity Trust (2007), a funding mechanism, to ensure the safety of the collections.

Though agrobiodiversity has been listed as one of the thematic programs of the Convention on Biological Diversity (COP Decision III/11 1997), in which parties has been encouraged to develop national strategies, programs and plans, yet the progress in implementing them is slow. A great interest in conserving natural ecosystems and endangered species has so far shown by countries of the Convention. This is due to the fact that natural ecosystems and endangered species are more attractive to conservationists than agrobiodiversity which to many is already in the hands of the UN-Food and Agriculture Organization. Moreover, the concept of agrobiodiversity itself has not been fully absorbed in the conservation of biological diversity. This socialization of this group of biodiversity to the conservationists of biodiversity needs to be further promoted.

Cultural Diversity Shapes Agrobiodiversity

Man has dependent on biological diversity since his inception and has developed efforts to managing his surrounding to grow crops and breed animals. In this planet there are many types of ecosystems and each ecosystem offers different species of plants and animals which man can choose for their needs. Like ecosystem diversity, human society also shows cultural diversity. The present day languages which are spoken in the world reflect the occurrence of cultural diversity. It is interesting to note that co-evolution between many plants used by man and human culture has been well documented (Bye, 1993).

Before the era of agriculture all food were gathered from the wild. In this way the number of people that can be fed was limited and there was uncertainty in the food supply from day to day. With the number of people keeps on growing, the need to domesticate plants and animals became apparent. It was estimated that with extensive agriculture 10 people can be fed instead of one as that with hunting and gathering. That number was further increased into 100 persons with intensive agriculture (Wood and Lenne 1999).

Harwood (1979) in discussing small farm development, especially in the tropics where typical farm of 3 to 5 hectares are in existence, stated that the development proceeds through a definite series of growth stages, i.e.,

Stage I : Primitive hunting and gathering. It is believed that at present partial hunting and gathering systems are still found in remote places in South East Asia.

Stage II : Subsistence-level crop and animal husbandry. In this type of farming system a great variety of crops and animals are tended. Almost all produced is consumed at directly.

Stage III : Early consumer. At this stage farmers are able to market a small percentage of their farm products.

Stage IV : Primary mechanization. This stage is characterized by the ability of the farmers to rent or purchase a source of mechanical power.

Tropical countries which are rich in biological diversity are also rich in agroecosystems diversity. The modification of natural ecosystems into agroecosystems to produce more goods has changed the ecological landscape. In consequence, wild plants and animals were pushed outside their natural habitats. Each agroecosystem varies widely in the number of crops they contain If these crops are linked with their pests, diseases, as well as their associated organisms then the number of the agrobiodiversity components is even higher, not to mention the inclusion of animal breeds. The variation of crops and breeds contribute very much to the variation of culinary in each cultural community.

Knowledge to select plants and animals and then to manage them in the agroecosystems has advanced with time. Through trials and errors knowledge has been accumulated as to planting seasons of crops, preparation of planting materials, time of weeding, etc. Such traditional knowledge has been improved through generations in stage II and III of Howard’s stages of small farmers. In stage IV, inputs from modern knowledge began to penetrate traditional knowledge.

Rural Community in Indonesia

In term of human population Indonesia is ranked as no 4 in the world, i.e., after China, India and the United States. In 2005, the number of population was recorded as no less than 220 million. Though the islands of Indonesia are amounted to more than 17.000 islands, only Sumatra, Jawa, Kalimantan, Sulawesi, and Papua are big in size. More than 55% of the Indonesian population lives in Jawa, which is the smallest island of the five. Therefore, Bali and Madura the two small islands adjacent to Jawa are equally densely populated.

More than six decades ago Indonesia proclaimed her independence (1945). At the beginning of her independence, almost 70 percent of the population lived in rural areas. The trend of urbanization has reduced the number to 55 percent in 2005. However, those who remain staying in rural areas still depend on agriculture for their live. Indeed the profile of rural areas after more than six decades of independence has not changed much (NATURINDO 2006). To many Indonesian's mind, rural life is always quiet and peaceful. Low land rural landscape is dominated by rice field with cow and buffalo. Upland agriculture is basically mixed cropping system. In some areas where water is abundance then inland water fishery decorates the landscape. In high elevation vegetable and tea/coffee plantation are part of the landscape. Besides, there are also land use systems and practices in which woody perenials are deliberately integrated with crops and/or animals in the so called a Agroforestry systems. Therefore careful selection of species and good management of trees and crops are needed to maximize the production and positive effects of trees and to minimize negative competitive effects on crops. This system is widely applied to improve partnerships between communities and plantation companies.

There are more than 70,000 formal villages in Indonesia. There must be hundreds of distinct village communities practicing traditional agriculture in different agroesosystems. Realizing the many types of agroecosystem in Indonesia, Ford Foundation, Indonesia supported the Research Group on Agroecosystems (KEPAS) of the Ministry of Agriculture, to collect data, review the existing farming systems and then publish guide books on how to improve the traditional practices. Unfortunately, monitoring and evaluation processes which were essential to measure the implementation of the guidance seemed lacking, Thus, traditional ways to practicing mixed cropping in many agroecosystems are only slightly affected.

Agrobiodiversity is the spearhead of the utilization of biodiversity. While it is true that Indonesia is one of the megabiodiversity countries, the facts are that many crops and breeds in Indonesia are introduced species. Of the four plant species used as staple food, for example, only rice is originated here. The same holds true for vegetables and pulses. Li (1970) stated that in this area the leaves of many species are consumed raw or cooked as vegetable. Therefore, almost all leafy vegetables are introduced species since there has been no urgent reason for cultivating local producing leaves species for vegetables.

As far as tropical fruit and timber trees are concerned Indonesia is the center of their diversity. However, only a small number have been selected so that desirable cultivars are available. Most native fruits and timber species are semi domesticated in home gardens, a special type of agroecosystem developed near the house, in which tree crops and annuals are grown together for food, energy, and health purposes. In this way there is no standard form of home gardens since each owner has his/her own freedom to grow whatever species he/she thinks are valuable to him/her. It is worth noting that the major components of home gardens are local species. High economic value species may be introduced in home gardens from somewhere else.

There is no doubt that erosion of native useful plant species and the knowledge associated with them is indeed going on. Undesirable useful species are easily substituted by more valuable introduced species and thus several species are no longer commonly grown in home gardens. Tuber crops such as suweg, (*Amorphophalus campanulatus*), uwi gembili (*Dioscorea acuelata*), and gadung (*Dioscorea hispida*), cannot compete with cassava and sweet potato, while legumes such as velvet bean (*Mucuna pruriens*) and kecipir (*Psophocarpus tetragonolobus*) are at present rarely seen in the market. Among the fruit species, mundu (*Garcinia dulcis*), rukem (*Flacourtia rukam*), kemang (*Mangifera caesia*), and kapulasan (*Nephelium mutabile*) are becoming rare. The erosion of timber species is much more alarming. Only a handful of native timber species are already selected for semi domestication. Many of them still grow wild in the forests. With the fast disappearance of virgin forests in Indonesia, the native species go with them.

Agrobiodiversity in a Changing Indonesia

Though the majority of farmers in Indonesia are small farmers, the impacts of modern agriculture can be seen especially in rice farming. Since the introduction of high yielding varieties from the International Rice Research Institute in early 1960s, rice farmers has adopted the new way of cultivating and harvesting rice which in turn pushed away the traditional practices. Together with all countries in S.E. Asia which adopted IRRI rice varieties, Indonesia has loss many of her rice genetic resources in the field. IRRI together with the National Agricultural Research Institute have collected the traditional varieties which are no longer in used by farmers and conserved them in IRRI's Gene Bank. A set of duplicates is retained in this country.

As high yielding rice varieties, new varieties of corn, cassava and sweet potato have been released in Indonesia by the respective international agricultural research dealing with those crops. The impacts on farming systems are not as dramatic as that of rice. Moreover, the three species mentioned are introduced species for Indonesia, thus their wild relatives are not found here. However, introduced early varieties which have been selected by local farmers, and have adapted themselves to local condition have declined in use. Earlier harvest time, high yielding and uniform in performance of corn varieties are easily accepted by farmers Such criteria are driven not only by their incrasing needs but also by the markets. With cassava and sweet potato, newly introduced varieties are not significantly known by farmers.

While it is true that many types of agro ecosystems are still exist in Indonesia, small farmers are sensitive to change, especially in those places where isolation is broken. They learn quickly the use of chemical fertilizers, pesticides and herbicides as soon as they are available in site. The understanding that certified seeds will guarantee good yields has stimulated their use. Linked with the certified seeds are artificial fertilizers and pesticides. Another driving force to produce more in their farms is the need of cash. Without cash they cannot send their children to school; without cash they cannot buy radio, television, even hand phone.

We are in the era of globalization. No country in this world is able to close their doors to the impacts of global economy and culture. The uniformity of global culture affects big cities in Indonesia. Because of her big population number, Indonesia has become the big market for foreign goods. It is sad to observe the agricultural products, such as fruits and vegetables, are flooding the Indonesian markets, not to mention rice, the staple food. Local products cannot compete with the import goods in quality. What will happen to our agrobiodiversity then?

Yes, we agree that we are rich in agrobiodiversity. Yes, we are aware that those agrobiodiversity is potential to fulfill our basic needs. Yes, we realize that we have to unravel the potential and conserve what we have for the future. But what we do not comprehend is that the management of our biodiversity is entirely in the hands of small farmers!. They are the one who decide which component of biodiversity should stay in their land and which one should no longer be there. No one can decide for them. Small farmers are land hunger too, the same way as those who like to grab land for plantation or for other purposes. The difference is that small farmers would like to have larger land to extend their farm to forested land nearby their farms whether or not the land is protected areas. For plantation and other purposes the government issued the permits.

In addition to the abandonment of agrobiodiversty by farmers, the coverage of agriculture land is also shrinking due to its conversion to industrial, settlement, and public infra structure. At the other side of the stiry, ever increasing number of population also bring high demand for food supply. Intensive way of managing agriculture becomes the only solution. Its consequence is obvious, the declines of the local crops and breeds.

National Issues Related to Biodiversity

Since the fall of President Soeharto (1998), Indonesia has experienced political instability. In ten years after his absence Indonesia was administered by four different presidents, i.e., Habibie, Abdurrahman Wahid, Megawati, and Yudhoyono. Because of this political instability, there is no social and economic stability. In consequence food (read: rice!) insecurity colors the country. The worry that food insecurity will always be a problem for Indonesia was expressed by the first President of Indonesia: Soekarno when he did the ground breaking ceremony of Faculty of Agriculture-University of Indonesia (1955). This faculty has developed into a famous agricultural university, Institut Pertanian Bogor.

After years of continuous efforts, Indonesia was able to achieve self sufficiency in rice (1983). To recognize her achievement in rice production, FAO granted an award to President Soeharto. Unfortunately, the enjoyment of being self-sufficient in rice did not last too long. Indonesia has slipped back to a rice importing country till today. That Indonesia is endowed by biological diversity and that the biological resources are important for agriculture and industrial development Soeharto was well aware of (Soeharto 1990). He stated further that the issue of biological diversity cannot be separated from the issues of population and economic development. Therefore, the need to control population growth through family planning in Indonesia was emphasized. However, due to political change, activities on family planning has been somewhat neglected since the fall of Soeharto. The size of population in reference to food supply is hardly talked about at present.

Food security was a hot issue addressed in the Science Congress of Indonesia of 1979. Many scientists believe that food security is not identical with self sufficiency in rice production. Their cry was heard by the government, therefore since PELITA II (Five year Plan for National Development II, 1974-1979) food diversification program was on the list and remained on the list in the following PELITAs. Under this program many activities were executed, however, no satisfying results were achieved. For the year 2007 Indonesia has plan to import 1.5 million of rice. In June 2007 Perum BULOG has signed to import 1,117,097 ton rice (ANTARA 2007). Realizing the danger for Indonesia to highly dependent on imported rice, President Yudhoyono expressed his commitment to revitalize agriculture (2006). It is so timely, therefore, that the importance of agrobiodiversity for food security is put on the table.

At the moment, for national food security the number 1 issue is how to import enough rice for the next several months, a priority setting which nobody argues. Unfortunately problem on national food security is only being response by providing sufficient rice stock even though taken from imported rice. At village level, agrobiodiversity may contribute highly to food security, especially at places where the urban influence is a minimum. This assumption is based on the facts that a number of crops and animals are still managed in many agroecosystems and the owners of which are making full use of what they have. In 1999 during the economical crisis most of the communities were suffering from the high price of rice. Communities began to look for local alternative food, which had been neglected when rice prize was cheap. They turn to tuber roots. To help community revitalize the many species of tuber roots as their alternative food, KEHATI began to work with community in many villages of five districts in Yogyakarta. Most of the farmers here are practicing dry land agriculture, where in tuber crops are suitable species. Thus, species like suweg (*Amorphophallus campanulatus*), kimpul (*Xanthosoma violaceum*), uwi (*Dioscorea alata*), gembili (*Dioscorea aculeata*), garut (*Marantha arundinacea*), gadung (*Dioscorea hispida*), and ganyong (*Canna edulis*). To keep the communities' interest in maintaining tuber crops in their land. Different food products such as flour, chips and cookies from those crops have been promotede (Mendamaikan konservasi dan Pemanfaatan (KEHATI 2004)). Of course not every household is able to fulfill all aspects of food security, but at least the quantity of daily food required is secured. A more comprehensive study is needed to substantiate this assumption.

Mainstreaming agrobiodiversity into agriculture development will be as difficult as mainstreaming biodiversity into the development processes. What more, dealing with agrobiodiversity means dealing with a system where many crops and animals are in existence, including the human being who manages that system. So there is a complex inter-relationship between components in agrobiodiversity that need to be considered. Therefore, a thorough review of 1970s KEPAS works should be attempted to give a general perspective to the types of agroecosystem that we have, the list of recommendations forwarded for actions, the level of difficulty that one may face, etc. In this way we are not reinventing the wheels.

Many plants and animals managed in the existing agroecosystems are generally generated from local sources. So, it will not be surprising if the majority of these groups of species are native species which are in the process of domestication. Some are well selected, but many are just brought into cultivation. Thus, an agroecosystem can be regarded as a man made ecosystem in which utilization and conservation of species go hand in hand. With the many types of agroecosystems it can be expected that many species of plants and animals of local value are conserved. At the same time wild species of plants, animals, and microbes associated with those crops and animals enable to interact freely.

If we agree with the global nation that the future availability of agrobiodiversity is in the hands of small farmers, how could we make sure that the small farmers are not going to abandon them? Do not they like to replace the not wanted crops with those that are more productive? Of course they have freedom to do what they want to do. There is no guarantee that small farmers will keep everything intact in their field, unless they receive benefits from doing so. We never discuss the rights of small farmers. During the discussion on empowering villages (NATURINDO 2006), there was a recommendation that each village should produce certain crops, so that there will be no over production of certain crops in time of their harvest and competition between villages can be avoided. This idea is not simple and further substantiation is needed.

The Role of Scientific Community in Enhancing Agrobiodiversity

It is interesting to note the comment of president Yudhoyono on the contribution of science and technology to national development, when he officiating the new Herbarium Bogoriense in Cibinong (2007). According to him science and technology has not contributed much to the national development. Whether or not he really meant to deliver the statement or that statement was merely an interpretation of the reporter(s), no written document is available to verify it.

Genetic resources for food and agriculture are included in the broad term of agrobiodiversity. Long before Indonesia ratified The International Treaty on Plant Genetic Resources for Food and Agriculture (2007) for almost three decades a group of interested scientists have been conducting research on genetic resources of Indonesia. Papers on the collection, utilization, and conservation of genetic resources have been accumulated. The question remains the same: how many new varieties of crops and new breeds have been developed from the vast materials that we have in Indonesia? Further, how good is our collection of genetic resources as of today.

Scientific community can be the agent of change. So if we do believe that agrobiodiversity is indeed important for food security at household level, even possibly at village level, cannot we mobilize our creativity to dealing with it? The basis to take actions is already in the shelf, i.e., the KEPAS group. A committee on National genetic resources is in place. Within the Ministry of Environment there is a unit specifically mandated for biodiversity in the context of the Convention on Biological Diversity. Under LIPI there is a research institute mandated for doing research in biology. The same holds true in the Department of Forestry and the Department of Agriculture, not to mention the number of research institutes dealing with biodiversity, under the universities which are scattered all over Indonesia. Competition is the sign of living being. That very word is planted into the mind of scientists. We are now living in the era of intellectual property rights culture. Every step of our work should be protected from others if we want the credits to our name. However, most of us are civil servants though we also wear private sector hats sometimes. Therefore we should honor the word symbiosis to work together for agrobiodiversity. The number of biodiversity we have is enormous. We cannot possibly develop them all at the same time. Therefore setting priority need to be done.

Our neighbors, Malaysia, Thailand, and the Philippines have more or less the same useful species of plants and animals with us. Basic information on those species had been collected (PROSEA series). Our neighbours have set priority on what they like to develop. Malaysia, for example, has identified only ten fruit trees that the government will put resources on. The Philippines, through her PICAARD, every year develops plant varieties and animal breeds that farmers can adopt and adapt them in their field. Thailand is famous with her commercial native fruits and ornamental plants. Cannot we agree to do the same? What we need is an architect or architects who can draw the road map to be followed by all of us. We have National Research Council. We also have the Indonesian Academy of Sciences, but why does our contribution to national development have not been significant? Then the same question is asked: where the fund needed for doing all research and development comes from? May be agrobiodiversity can unite all of us to find resources to do the job. We do hope that this discussion do not end here, rather this is the beginning of our new commitment to revitalize agriculture!

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Status on Traditional and Local Knowledge on Management of Agricultural Biodiversity

Ronny Novianto

The Perspective of World Food Day Farmer's and Fishermen of Indonesia
E-mail: ganjuran@indosat.net.id

Introduction

Indonesia is an agrarian country which major people engage in faming as a basis of their livelihood. As an agrarian country there about 25 million farmer's family that have to feed the total population more than 200 million.

As an agrarian country Indonesia rich in term of biological diversity, 300 e8thnic and 300 languages include 580 dialectic, religions and beliefs, varieties of culture, and thousands of islands stretched out from Sabang to Merouke (Papua). Many researchers amazing to the panorama of Indonesia and interesting to conduct field experiment on biological diversity, social structure or just having tourism visits to enjoy beauty scenery.

While ethnic diversity represent traditions and culture draw people from abroad to directly visit and interact with them. On the other hand, thousand of islands about 17,500 big and small islands offer native beauty of God creation and attract visitors to stay along. The rich of cultures and traditions adhere on the life of farmers as a major people of Indonesia. The traditions as an indigenous knowledge on farming system since long time ago which factually could provide their local food system and family health care and maintain diversity in the agro-ecosystem such as varieties of food crops cassava, corn, rice, herbal crops, and all living forms in the soil.

Nevertheless, modernization of farming system especially after the Green Revolution came in 1970s, farmers obligated to implement such technology aim to produce more food yield to feed more people which high external inputs approach by the miracle seed called "IR" and package of chemical inputs which had displaced the farmer's seeds include the traditions on farming system (indigenous knowledge) and so far lost of biodiversity in nature due to the excessive used of synthetic chemical fertilizer, pesticide, etc.

Based on the fact shown by Perlas and Velve (1997) there about 8,281 rice varieties from Indonesia contributed to IRRI (International Rice Research Institute) as genetic materials for research means, other problem still exist up to now are farmers depend on industrial seeds to plant, and other chemical inputs had caused declining of soil fertility, the consumerism culture increased due to the ideology of economical growth, and the important thing is that most of farmers especially rice farmers had already left indigenous knowledge on farming system. Model of agricultural development in developing countries as well as Indonesia does not take into account to the existence of traditional farming system (Sutanto 2000). The government presumed that traditional farming could not increase the food production yield to fulfill the national food needs. There is still different perception on the food security in practices. Traditional farmers assume that enough food means in the context of local food system could provide the local food need to met the people in the local context, while the government think that enough food means if there is enough stock of rice for people. Import will be a key answer if there is a scarcity of rice stock in the regions.

The Concept and Practices of Indigenous Knowledge in Agricultural Production

Indigenous knowledge had been developed long time ago in many countries. Fust (1998) explained that the practices of indigenous knowledge impressively shown by Hawaiians agricultural skills when the Cook expedition from their first visit to the islands in 1778, so far the success of Hawaii's agriculture is recorded by Dr. Menzies naturalist of the Vancouver party in 1793 who saw exuberant field which for industry of cultivation and agricultural improvement could be scarcely exceeded in any country in the world. The local knowledge applied through preventing people to destroy the forest and watershed, thus a diversity of species and habitats thrived.

Reij *et al.* (1986) documented that indigenous knowledge (IK) of a farming population living in specific area is derived from the local peoples' past farming experience, both that handed down from previous generation and that of the present generation. Farmers' practical knowledge about the local ecosystem, about the natural resources and how they interact is reflected in their farming techniques and their skill in using the natural resources to gain their livelihood. IK is far more than merely what is reflected in technical methods. It also entails many insights, perceptions and intuitions related to the environment, often including solar cycles, astrology, and meteorology and geological conditions. This folk wisdom is usually integrated with belief system and cultural norms, and expressed in tradition and myth.

Pawluk cit Sutanto (1992), defined that Indigenous Knowledge in farming system include the complete science which developed within the certain ethnic and culture to fulfill the daily need in accordance with the local condition. The information gathered and orally tutored to the generation subsequently.

Moreover, indigenous knowledge stays in progress as reported by Werner cit Sutanto (1991). Indigenous knowledge also rely on the genetic and physical diversity as described by Reijntjes *et al*. cit Sutanto (1993) that traditional community could fulfill their daily need and diverse of genetic resource which have complex function to meet family need and community at large to produce food, medicines, fire wood, wood for house building, forage, improve soil fertility to prepare the next unfavorable planting time.

Based on the study of the Eastern Philosophy said that the concept about human and environment leave human as part of their nature, each is to form and be formed of (Wirjono 1993).

Aliadi *et al.* (1994) explained that indigenous knowledge/local knowledge of Danie's tribe in West Papua Indonesia used on traditional farming to fulfill many purposes such as health care, ritual of tradition, fire woods, and construction by benefiting all crops in nature. Thus, means that indigenous knowledge was used and indirectly been able to maintain crop's species diversity. There are 193 species covers 137 genera and 74 families they have been collected for many purpose such as medicine crops for stomach disturbance.

This community had strong relationship with their nature. It was indicated on their efforts to keep alive by seeking food crops, vibres, medicine from their nature which accompanied by strong tradition performance.

Javanese traditional farmers revealed that indigenous knowledge/local knowledge understood as the basic values to be alive within the family and the rural society. Indigenous knowledge in the rural area represents the local way of life to rule the attitude, ethic, social relationship of the society in relation to the God almighty and nature. They believe that behave this concept will make their life joyful because people always keep the balance.

So far, in Java there was a model of traditional farming called "*Pranata Mangsa*" (called biodynamic) that was introduced by Sri Susuhunan Pakubuwono VII (the former king of Surakarta) in 1885. In the *Pranata Mangsa* one year calendar divided into 12 seasons each season has character to describe about wind, temperature, and nature condition. Farmers in Java led by the King to use this concept to attain the best growth and yield, many of the old farmers still remember and use this but most farmers do not apply this indigenous knowledge. Many rice farmers we interviewed say that applying this method avoid plants from pest attacked (SPTN report 1997).

FAO (Food and Agriculture Organization) launched World Food Day commemoration since 1981. Every year the theme is change. In 2005 World Food Day that is cultural dialog in agriculture mentioned that innovation has occurred within indigenous people and their knowledge. All cultural and agricultural systems have conserved some historical elements and transformed others in order to enable people to survive.

Long time ago, the rural community in Tana Toraja where the farmers engage in farming as the main livelihood, indigenous knowledge used to manage agricultural cultivation activities. Those cover activities on determining the planting time, land tillage, selecting seeds (part of seed's treatment), pest management, etc.

Based on Tana Toraja ancient story (a cultural tourism district in South Sulawesi about 350 km from Makassar a capital city), they called *tallu lolona* (three main factors on *toraja* community life) that are:

1. Human
2. Animal
3. Plants

The relation between three factors as described that: Rice eaten by farmer means rice has spirit to give their life to be eaten as well as pig is eaten by human. In the past, they cultivate local rice once a year for six month with local knowledge for specific purpose such as many types of rice varieties will be use to have a party for the death. They stored rice harvest in the place named "Alang". Due to the entering of Hybrid Rice variety Tana Toraja farmers never plant local rice varieties anymore. The myth live in Tana Toraja community is that in the past a goddess of rice called *Dewi Sri* had an agreement with mouse when the seeds falls in the valley and only mouse could take those seeds, then the *queen/goddess* asked to mouse:" What do you want and the mouse answer "I don't want anything but please serve the food in your field for me", said mouse. That's why the ancestor always plant cassava/other food crops in the bounded of the rice paddy fields as keeping promise of the agreement.

They eat two times a day eat at 2.00 p.m and after 06.00 p.m it should be done before work in the field, now change eat to work. It means that farmers reduce food consumption which low consumption lifestyle approach. After themodern farming with high input came then the local knowledge lost includes the genetic material of hundreds of local rice varieties.

In Mano-Ruteng-NTT, where SPTN-HPS conducted the project since 1999, documented that local farmers plant coffee without management, they only clearing the land and burn the grass and then plant coffee, maintaining mulch by making a gully in the down side of the canopy to prevent soil erosion and retain water run off during rainy season. Their local knowledge say that nature is already fertile, they are really depend in nature, waiting the generosity of nature to give if the harvest coffee is go up in yield they feel it is a bless, but if the harvest not really success it's also a blessing. This is why the soil relatively fertile.

SPTN HPS observed that since 1990 (as the birth of World Food Day Farmer's and Fishermen Movement of Indonesia-WFDFFM) farmers in some places of Indonesia such as in South Kalimantan, Bima, Tana Toraja-South Sulawesi, Manggarai-Flores, Java, Bali, South Sumatra (where SPTN HPS implement the project assisting farmers on implementing sustainable agriculture), only less farmers apply indigenous knowledge on farming system especially for food production, indigenous knowledge principle on farming system which the use of ecological sustainability approach shifted into the ravenous one. We also have gotten a lot of information within our assistance to the farmers in the grassroots that in some places traditional farming being developed in the rural community since centuries ago and proven be able to provide the local food need (report of SPTN 2006).

Initiatives to Revive and Develop Indigenous Knowledge on Farming System

As described above that IKS play a role on enhancing genetic material, so revival and maintaining IKS is a must for multi stake holders in regard to agricultural community. If farmers replace IKS with modern farming then agro biodiversity will be consequently reduced.

Table 1. Number of local rice varieties breeding within the WFD farmer's groups.

No.	Province	Number of Farmer's groups	Areas of Organic conversion process (ha)	Number of local rice seeds collection
1.	Yogyakarta	34	160	69
2.	Central Java	76	443	99
3.	West Java	5	29	20
4.	East Java	26	122	18
5.	Bali	3	9	2
6.	Toraja-South Sulawesi	8	82	15
7.	NTT (East Nusa Tenggara)	12	7	13
8.	Bima-West Nusa Tenggara	4	6	4
	Total	164	1,058	237

Source: Research and development of SPTN HPS (2006).

The Birth of World Food Day Farmers and Fishermen Movement of Indonesia (WFDFFM)

WFDFFM is a Social Movement

The organic agriculture movement of WFDFFM started with Ganjuran Declaration in October 16th 1990. The vision and mission of Ganjuran Declaration is to build sustainable agriculture and rural development which is ecologically sound, economically feasible/viable, culturally adapted/rooted, and socially acceptable to everyone and everything. In short, the Ganjuran Declaration developing lifestyle that is becomes a blessing for everyone and everything for justice and peace and integrity of creation (Utomo 2006).

SPTN-HPS (Secretariat in service to the World Food Day Farmer's and Fishermen) which definitely established 2 years after Ganjuran Declaration in January 1992, work through sustainable agriculture and rural and marine community development as the vision and mission of WFDFFM.

In March 2002, SPTN-HPS held the General Assembly (GA) of World Food Day Farmer's and Fishermen's Movement which proceed by regional meeting. The GA targets were to reflect vision and mission, to share experiences, to evaluate activities and to plan the program for the five coming years (until 2007). Then, SPTN HPS tasked to provide service and empower farmers and fishermen as targeted on the program mentioned.

WFDFFM promote farmers to revive and maintain the Practices of indigenous knowledge through sustainable agriculture and rural development. The three main programs are Sustainable Agriculture Pattern of Production as well as Sustainable Pattern of Consumption. In practice it is against consumerism which has become the main trend in the society (Utomo 2006). Because the consumer mentality, people tend to spend more than they earned.

Examples of indigenous knowledge undergone on agriculture

1. To form the World Food Day farmer's groups called "Paguyuban HPS"

   Paguyuban is a gathered of farmers which have dynamic movement to respect other farmer through humanistic relation approach. Paguyuban is a media for farmers to share experiences, exchange seeds, exchange knowledge which locally rooted, planning activities and evaluation. All is conducted to achieve the goal (vision and mission of Ganjuran Declaration 1990). Paguyuban is used to disseminate farmers on the technology of sustainable agriculture. In the national level we used name of World Food Day Farmer's and they are given the autonomy to use local term in the local level.

2. Collecting of local rice varieties through Community Seed's Bank

   Community Seed's Bank represents a strategy for maintain of genetic diversity in crop/ plant species and also serves as a back-up for local self sufficiency in seed (Worede 2000). It is understood as community based stores used for distribution of seed and grain to the local communities on loan basis.

   Since the first of Ganjuran Declaration stated in 1990, SPTN HPS started encouraging farmers to explore and cultivate local rice varieties. At that time Rojolele (local name of rice) planted 6 hectares in Bantul Yogyakarta which could fetch 4 tons/hectares then the local seeds are developed and exchange. Another part in Bantul farmers collected various as well as farmers in Boyolali in 3 years after (1993) also planted Rojolele rice. The method on cultivating Rojolele should apply indigenous knowledge system since sowing the seeds, land tillage, harvesting technique (using knife to cut the panicle). In 1996 farmer in Karanganyar found out *menthik* as a local rice then planted it which fetched 6 ton/ ha through duck manure application. Then WFDFFM in the grassroots explore and select the local rice varieties and renew for seed purpose.

SPTN HPS had ever been collaborate with Balitbio Bogor in 1999 to conduct field trial (domestication) of 200 hundred of local varieties comprise 100 irrigated area an 100 upland rice. The result there are about 50 local varieties planted up to now, b and 20 local maize planted in farmer's field of Dlingo-Boyolali, Sedayu-Bantul District, Bukateja-Purbalingga-Central Java.

3. Practicing nutrient balance in the field

   In nature there is a nutrient cycle (food chain) where each chain depends to each other. The chains are living organism (both plant and animal). In the farmers had local knowledge to return all waste material (post harvest) to the soil, this treatment could enhance soil biota indicated by the emerging of earth worm and other soil organism.

   Natural fertilizer (organic matter) represent a root of local culture on agricultural production technique in the past time, farmers really aware the benefit of natural fertilizer to make the soil fertile, it also aim to maintain soil biota/microorganism to decompose organic matter in the soil. After the used of chemical fertilizer by farmers then farmers skill and knowledge on identify, manage, and apply natural fertilizer in the farm.

4. To avoid pesticide and replaced with natural pesticide to keep the balance between pest and natural enemy. In the past traditional farmers use ash to control nematode or insect attack, broadcast cutting of tobacco stump in the paddy field before planting, or even they walking around the field by praying. The coming of chemical pesticide had changed farmer's pattern of thinking on controlling pest. Farmers no more keeping the balance through synthetic pesticide application, farmers destroy their environment and poisoning the food and killing natural enemy in the field. Through the assistance WFD farmers had collected 78 natural techniques on controlling pest and disease based on the local culture.

5. Promoting farmers to apply multiple cropping systems in the agricultural production. In the past, farmers usually used of Mix farming. This aim to cultivate the land optimally and provide the favor space for small climate to the growth of those crops and other friend of farmers such as pest enemy, soil bacterial. The example shown in the farm of farmers in Banjarasri village Kulon Progo they plant ground nut in between cassava lines and in the border they plant leguminous crops to provide forage and green manure. This indigenous knowledge had been developed since long time ago as well as in Gunungkidul district.

6. Promoting farmers to use herbal crops for routine health care of the family. It is important that since in the past farmers in some places like in Kulon Progo-Yogyakarta (11 paguyuban) and Karanganyar (10 paguyuban) started consuming herbal crops such as

turmeric, galangal, ginger, sambiloto, brotowali, papaya leaves, etc for health care. This local knowledge already continue since long time ago and significantly keep the existence of herbal crops (enhance biodiversity) since these crops have economic and health value.

7. Develop Network and partnership

   To develop indigenous knowledge for agricultural biodiversity enhancement need multi stake holders role. SPTN facilitate network between farmers and scientists in various way such as:

   Farmers play role as the subject (executor) to develop sustainable agriculture contain the principle of indigenous knowledge and biodiversity.

   Scientist will conduct study on seeds development, practice of sustainable agriculture which ecologically sound, economically viable, socially just and lead farmers to conduct research in simple way.

   While NGO facilitates the access of farmers to collaborate with scientist, partners that SPTN has collaboration with are as follows:

   a. Soil scientist from Gadjah Mada University faculty of agriculture.
   b. Economy Faculty of Sanata Dharma University
   c. Scientist from Balitbio Bogor
   d. Sociologist from Pusat Pengembangan Pedesaan dan Kawasan University of Gadjah Mada.

   While to strengthen the movement WFDFFM, SPTN HPS collaborate with religious leaders, national and international NGOs, village government and district government.

Conclusions

Indigenous knowledge will be a key role on enhancing agro-biodiversity. Indigenous knowledge proven being alive adhere in traditional farmers/ traditional community over millennia.

The practices of sustainable agriculture will have significant contribution to revive indigenous knowledge and further enhance biodiversity in nature.

The community seeds bank in the village is a key strategy to maintain genetic material in the village both *in situ* and *ex situ* and place the seeds as a power of the farmer's livelihood but not the multinational company.

Farmers, scientist, and NGOs should hand in hand to keep indigenous knowledge in order to maintain genetic material in agricultural biodiversity.

We recommend the Government to shift way of thinking about indigenous knowledge as a potential technique which is dynamic that will be an input to firstly shift the agricultural paradigm and secondly make the policy on agricultural development.

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TRAINING AND AWARNESS

Capacity Building in Management of Genetic Resources (Education and Training)

Ronny R. Noor

Department of Animal Production and Technology, Faculty of Animal Science, Bogor Agricultural University, Bogor, Indonesia
E-mail: ronny_noor@yahoo.com

Introduction

Agro-biodiversity is a critical component of global biodiversity. Over 75% of the world food and agriculture is produced by fewer than 25 domestic plant and animal species. The active manipulation and management of the genetic resources found within these species is absolutely essential to attainment of global food security. Pressure of increase global food production, productivity, and sustainability is intense and increasing. The identification, acquisition, and further development of plant and animal germplasm that is both highly productive and adapted to local condition is a global priority and led to unprecedented levels of international movement of agricultural germplasm.

In order to demonstrate the important of biodiversity, animal genetic resources will be briefly discussed. Farm animal genetic resources (FAnGR) are among the most valuable and strategically important assets that a country can have. Domestic livestock production is crucial for sustainable agricultural production systems and for future food security and poverty alleviation in developing countries. FAnGR play multiple roles in many economies. In the rural areas of developing countries FAnGR provide a year-around flow of essential food and other products (hides and skins), employment, income, draft power and manure for crops production. Food from livestock and poultry such as milk, meat and eggs are rich in energy, protein, vitamins and micronutrients, which are particularly important in the diets of the most vulnerable groups, i.e. children and pregnant and breast feeding woman. In developing countries malnutrition is common, especially among the most vulnerable groups. Meat, milk and eggs therefore provide an important opportunity to overcome this problem. It is estimated that more than 70% of the world’s rural poor derive their livelihoods from livestock; this include 194 million pastoralist and graziers, 678 million mixed farmers and 107 million landless livestock keeper. Empirical evidence of the contribution of livestock to sustainable livestock of the world’s rural poor exist, including the potential for improvement of such livelihoods through investment in livestock development in all developing regions of the world.

The global situation on biodiversity is critical. For example, about 30% of the world’s livestock breeds are currently under threat of extinction; a large proportion of these are found in developing countries. There are no conservation programs for more than 75% of the threatened breeds. The United Nations Convention of Biological Diversity (CBD) of 1992 emphasized the need to conserve the world’s biological diversity for present and future use. In 2001 FAO launched a global program to monitor animal genetic resources, analyze their status and support the development of national or regional action plans, including conservation schemes. In order to successfully undertake these schemes, in-dept knowledge of the key player in the area of conservation of biodiversity is essential.

Underlying causes for loss of agricultural genetic resources related to : 1. *General framework*: adverse incentives, such as subsidies for exotic breeds, macroeconomic and export constraints, lack of financing for the implementation of national agro-biodiversity strategies, lack of financing to reduce transaction cost in agro-biodiversity-promoting farming systems, lack of adequate legislative framework, lack of adequate institutional framework, lack of adequate conservation strategies, lack of integration of the national genetic resources management plans of strategies into the overall environmental strategy, disastrous situations, political crises, civil war etc. 2. *Farming system level* : abandonment of breed and crops for microeconomic reason, abandonment of breed and crops due to market failure, loss of resources, such as pasture, loss of knowledge about such matters as traditional practices and local varieties, 3. *Consumer demand*: change in nutrition habits and lack of consumer awareness, 4. *Natural disturbances* : alien and invasive weed, introduced with exotic seeds, changes in the diversity and density of bio-control agents, pollinators and soil microorganism, 5. *Research and information sharing*: lack of farmer-driven participatory research, lack of coordination and information-sharing between research and development programs, lack of adequate breeding strategies, lack of understanding special qualities and adaptation complex, lack of knowledge about the genetic resources of the country/region, lack of access to appropriate genetic resources and training for on-farm management and improvement, and finally, lack of awareness of important of adapted genetic resources to increase productivity.

International awareness of the role and values of genetic resources, and concern for the rapid loss, must be translated into effective action at the local, national, regional and global level. Management activities in the next decades will, to a large degree, determine the future role and contribution of genetic resources towards global food security. Research and capacity building at all level to improve the knowledge of indigenous and alternative genetic resources in different regions of developing world is required. The implementation of sustainable breeding strategies in tropical developing world will be instrumental in increasing awareness of the roles of plant and animal and their genetic diversity.

Human Capacity Building on Genetic Resources Needed

Development and implementation of genetic conservation and agriculture improvement program is far more complex in developing countries than in developed world. The limited number of trained genetics and breeding scientist in many developing countries id therefore become major constraints. In addition, few relevant training resources are available in these countries. Educational efforts in all levels, i.e. among teachers, students, policy makers, administrators, geneticists and breeders, are necessary to improve the awareness of the problems and the methods to be chosen for effective conservation and improvement programs in developing countries. Furthermore, relevant research in tropical environments, using both modern science and indigenous knowledge is necessary.

Most of the highly trained and experienced researchers in developing countries are based at national universities and research institutions (NARS), where facilities are used for both teaching and research. With sufficient facilitation and motivation, these institutions could effectively generate relevant agricultural technologies which, if adopted by farmer, would lead to improved farm productivity and farmer livelihoods, more so where universities and research institutes collaborate and complement each other. National universities and national agricultural research institute are the primary source of current and future generations of national researcher, teachers and policy makers and is therefore the engine for capacity building for sustainable food production in developing countries. However, in spite of the fundamental role of higher education and research in supporting development, the higher education institutions in many developing countries are chronically under-funded and face many obstacles.

Conservation and sustainable use of plant and animal genetic resources in developing countries are examples on the area where teaching and research are given too little emphasis, or are sometimes neglected altogether, worldwide. This results in low awareness of the need to develop appropriate breeding programs for domestic plant and animal in developing countries, and prevent poor farmers from benefiting from the projected agriculture and livestock revolution.

Designing a Capacity Building Project

In designing a capacity building project, idea and objectives should be clearly defined from the earliest step of the project. Development projects for human capacity building in developing countries often focus on training the trainers, i.e. scientist from national universities and research centers responsible for research and training of genetic resources for student at higher education levels. This should have a large impact because each teacher/researcher given refresher training within the project would, with their improved knowledge, awareness and skills, reach out to a large number of students and colleagues in their home institution. The effect thereby multiplied because students use and further spread the knowledge during their professional careers.

The specific objective of a capacity building project should at least include:

- Strengthening subject knowledge and skill in genetic resources
- Strengthening communication skills
- Catalyzing curriculum development, reviewing of course contents and using new and expending teaching methods
- Developing computer-based training resources
- Stimulating contact and exchange experiences and ideas among teacher and researcher from developing countries on research and training
- Strengthening the human capacity base of the project partners for work on genetic resources in developing countries

A Capacity building project should include a number of activities. The main activities are:

- Planning activities
- Training courses
- Development of training materials
- Following activities, including evaluation of impact

The planning and fact-finding activities should put more emphasis on:

1. Involving the target group from the very beginning
2. Assessing strength and opportunities and weakness and constrains in higher education and research in agricultural genetic resources within the different regions
3. Assessing the existing level of human capacity, teaching resources and ongoing research in the subject area
4. Identifying the interest and scope in strengthening knowledge and skill among teacher/researcher

The planning activities can be performed by region and included sending out a questionnaire, making country visits and holding a planning workshop.

The training courses are the most important activity for creating awareness among teacher and researcher in developing countries about the needs and methods to improve higher education and research on genetic resources. The course also will stimulate contacts and networking between the teachers and researchers in the region covered

The training courses at least should cover:

1. Importance and role of genetic resources for sustainable agriculture in developing countries
2. Characterization of indigenous genetic resources, design of sustainable breeding programs
3. Methods of genetic analyses in teaching and research
4. Computer exercise use of software, database and internet searches
5. Group project with design of conservation programs for indigenous breed or strain
6. Field visit
7. Teaching methods, including aspect on teaching and learning, examination methods, supervision of students´ research and how to stimulate educational development at universities
8. Science communication, such as scientific writing, oral presentation and poster presentation
9. Review of structure and content of training resources being developed by the project

The lack of literature and courses materials on genetic resources relevant to developing countries will lead to development of a computer-based genetic resources training resource. The training resource should be produce not only for the participant but also for other teachers and researchers in the filed of genetic resources for use in their teaching, in their research and in updating their own knowledge.

Follow-up activities are used to evaluate the impact of a capacity building project, and to stimulate and give feedback to the project team, and to representatives of the target groups. A follow-up workshop after a training course can be conducted in a particular region. The purpose is to gather representatives of previous course participant to discuss what direct impact the project had, and to exchange experiences in the process of implementation of new concept or ideas in the home countries of the participants.

The impact of the project can be partly assessed through questionnaires. The workshop program should include thorough discussions on the impact to date of a capacity building project on: teaching method, curriculum development and course content, research and research supervision.

Attempts and achievements made by the participants should be presented and the result, experiences, constrains, solution and way forward should also be discussed together with the summary of all the responses to the follow-up questionnaire. The workshop program should also include an evaluation of the computer-based genetic training recourses.

Experiences and Lessons Learned in Capacity Building

Ensure partners ownership and leadership: For long-term sustainability of capacity building efforts through self-monitoring and evaluation, ownership and leadership of the project by the project partners/countries need to be ensured. In case of the national projects, the country representative of the project must determine national priority actions. It is a fundamental principle that for positive outcomes of the capacity building process, including its long-term sustainability, the efforts should be nationally owned, led and driven. A high degree of national political commitments and leadership consistently over time is essential. Related implications of this principle are that country representatives decide on priorities and courses of action and their link to other national priorities. It is also implies self-monitoring, self evaluation and learning by doing.

Ensure multi-stakeholder consultations and decision-making: Principal stakeholders should be involved from the start of the planning process. National decision-making should involve multiple stakeholders, particularly with a view to tackling inter-sectoral issues. A necessary condition for effective and sustainable results is the involvement of principal stakeholders' right from the start of the planning process as full and equal partners.

Base capacity building efforts on the partner's self-assessment of need: Capacity building projects need to be demand-driven, therefore exploring the demand of beneficiaries early in the development phase of the projects is critical. National ownership and leadership is more likely when capacity building efforts are preceded by a self-assessment. The objective of capacity building efforts should be matching with the existing status of the capacities in the recipient country. Even when focused on problem-centered approaches, the efforts are often more successful when they are realistic, recognize and build on existing strength, knowledge and experience within countries.

Adopt a holistic approach to capacity building: All three levels of capacity building need to be addressed-the individual, the institution and the overall system framework in which the two operate and interact, as well as the formal and informal relationships between institutions. All three dimension of capacity building need attention. An inadequate emphasis at the system may diminish the impact of effort at the institutional and individual levels. A proper balance, therefore, needs to be established between all three closely interlinked, levels.

Integrate capacity building into wider effort to achieve sustainable development: Capacity is very fluid and has multiple uses. Any strategy to address capacity building must therefore recognize that developing capacities for global environmental action is closely related to and must be integrated with on going initiatives to enhance capacities for broader environmental management and for sustainable development in general.

Promote partnership: At their best, capacity building involves a collective effort and the multiple channeling of financial resources and expertise, with the key players (agencies, countries, civil society, donors, and private sector partners) having differentiate roles. Partnerships are most effective when they take the different skill and strengths, but also the weakness, into account. Wide-ranging partnerships, including for example inter- and non-governmental organization as well as the governments, such as Great Apes Survival Project and the Service for Implementation of National Biodiversity Strategies and Action Plan, will able to make a wide range of strength and potentials available for the success of the project. Such partnership might include a range of conservation approaches and different organization sizes and mandates. For example, NGOs might able to reach out with the capacity building efforts to local communities more effectively than other partner; NGOs might also be in a good position to provide technical support on the ground through their in-country experience and government contact. Intergovernmental organization could relatively easy facilitate meetings involving the governments of partner of target state. Some partners have better access to media than other, to achieve wider media coverage or might be able to increase the political backing,

Accommodate the dynamic nature of capacity building: Capacity building is a dynamic process with many facets: mobilization of existing potential that may not be utilized because it does not reside in the institution that is charged with the respective responsibility, or individual expertise may not be utilized because of organizational deficiencies, among other reasons; enhancement of capacity to avoid obsolescence through continuous utilization and by providing short-term courses, workshop, seminar and other training services; conversion of adjustment of existing capacity building to deal with the new problems; creation of capacity subsequent generations. Capacity retention is also a key challenge. Given that capacity building is not static but dynamic and iterative process, adequate monitoring and evaluation techniques with appropriate benchmarks and indicators are essential for learning-by-doing and for adaptive management. It is therefore important for the players to revisit the operational principles, strategic elements, tools and methodologies from time to time

Apply a variety of tools for capacity building: Capacity building efforts should be supported by variety of tools and methodologies. These could range from the more traditional methods to capacity building (such as workshop, in-service technical training) to those that offer greater scope both methodologically and institutionally (such as, networking, horizontal exchanges and cooperation, creation of multi-stakeholder project steering committees, sharing of project management responsibilities, internships)

Identify the target audience and choose the right approach for building their capacity: Targeted training needs a through identification of the audience which might be very specialized, for example customs officers charged with the enforcement of provisions of CITES, or protected area managers working a local site with communities. Problem might arise from staff turnover and right methodology and training material need to be selected. CITES has developed an interactive computer-based training program, avoiding wasting valuable in-person training time and resources if the trained staff if replace by non-trained staff.

Provide interactive computer-based training: Interactive computer-based training offers a focused and easily repeatable training program that can be used by many persons and at times of their choosing. Materials and the program of study can be aimed at specific audiences with particular responsibilities and information needs. Interactive computer-based training presents essential information, and guides the participant through a learning process to ensure that the participant has understood the concepts, principles and procedures presented. The interactive nature of training provides the means for the participant to practice using new information relevant to their work, and thereby understanding and retaining the information presented before being taken to the next level.

The Animal Genetics Training Resources (AGTR) developed by ILRI is an excellence example of computer-based training resources. The AGTR Version 2 is available in a CD and also available on the internet (http://agrt.ilri.cigiar.org). In general, AGTR is a unique and user-friendly interactive multimedia resource, targeted a researchers and scientist teaching and supervising graduate and post-graduate students in animal breeding and genetics. The main contents of the resource are **MODULE** and **TOOLS.**

The modules included are:

- Global perspective on animal genetic resources for sustainable agriculture and food production
- Improving our knowledge of tropical indigenous animal genetic resources
- Sustainable breeding programs for tropical farming systems
- Quantitative methods to improve understanding and utilization of animal genetic resources
- Teaching methods and science communication

Within the module text, there are link to other content of the resource, i.e. case study, examples, compendia, breed description etc that are relate to the module content. There are also link to other module, and to relevant resources that are available on the internet.

Under the tools menu, various sources of information linked to the modules include:

Case Study

Case study is written summary or synthesis of real-life experiences that capture indigenous knowledge. They give examples where programs of procedures were successful and where they weren’t and why, and they also identify knowledge gaps of local or regional activities in animal breeding and genetics in developing countries.

Breed Information

The breed information tool provides a database where all breeds mentioned in the modules or case studies are available. The following areas are briefly covered for each breed: origin and distribution, physical characteristics, peculiarity, breed status, utility. A photograph of the breed and a map of its location, as well as literature and websites for further information are also provided. Links are given also to some general breed databases available on the internet.

Maps

Maps presented provide an indication of the density and distribution of livestock in various regions of the world.

Examples

Examples provide illustrations of principles or methodologies that help improve the understanding of a topic. Two types of examples are presented, animated examples, with animations using flash media player; and examples on biometrics, based on real data.

Exercise

Various kind of exercise that can be used in teaching in animal breeding can be found under this heading, all with the purpose to improve students' understanding and learning

Compendia

Compendia (course notes) are condense text on specific subjects and can be provided to the students as course reading. The compendia included cover various aspect and genetic evaluation and selection, and there is also a compendium on science communication. Furthermore, there are software manuals, i.e. basic introductory guides that enhance use of software.

Clips and picture

Clips and pictures are intended to provide examples showing various livestock genetic recourses, or application of different experimental protocols under prevailing production and husbandry condition in developing countries. The picture provides an indication of the diversity available within species.

Glossary

In this section, a number of terms related to animal breeding and genetics are explained.

Library

The library contains full text document related to animal genetic resources

Search

A general search facility is available in the resource to search for an optional topic of interest. The search tool is a full text search engine that indexes all the text available of the resource, and will yield a list of documents and other contents where key words or phrases are found.

Web resources

The web resources leads to information on database, software, courses and course notes, organization and networks, and additional information sources related to animal breeding and genetics. By exploring websites one can find a lot of material that can be very useful in teaching and research. The website for each source in the web resources list is given in the URL row.

Develop and keep updated training material: A library of training presentation, in many cases multilingual, has proven useful but needs to be updated in regular intervals. The presentations need to be tailored to local needs, i.e. easily adaptable to include locally-relevant examples, or translation into international languages. All these processes should be as cost effective as possible. The workload for development, updating and translating of electronic training material must not be underestimated. Interactive material, for example, will need to provide for alternate responses and feedback to the learner.

Monitor the use and impact of materials: The use and impact of training materials will be difficult to monitor in most cases. Feedback mechanisms might be helpful, but need to be monitored and if necessary adapted themselves.

Choose the right trainer for trainers: CITES experience has shown that developing the training skills of knowledgeable staff is more effective than training trainers about the convention. While a trainer will understand how to impart knowledge, the complexity of CITES and the professional nature of the audiences indicates that a trainer who is new to CITES is unlikely to be able to answer difficult questions or provide practical guidance to complex situations. Being address such matters requires not only knowledge about CITES, but also the possibilities and limitations within national legislation, current conservation science, and so on. In addition, when addressing an audience of professionals, one of the most important assets a trainer can have is technical credibility. A trainer who cannot address and solve the audience’s technical problems quickly loses credibility and the audience’s respect and attention. Therefore, starting with persons proficient with CITES and imparting adult education, training, and group facilitation skill in an effective way of increasing the number of CITES trainers who can turn guide national audiences through a training process.

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Communication, Education, and Public Awareness on Genetic Resource Management

Tantono Subagyo

E-mail: tantono@gmail.com

Introduction

Biological diversity or biodiversity is the term given to the variety of life on Earth, including plants, animals and micro-organisms, as well as the ecosystems of which they are part. Biodiversity includes genetic differences within species, the diversity of species and the ecosystems. It is the result of the interaction of species, including humans, with one another and with the air, water and soil around them. This combination of life forms-ecosystems, species and genetic varieties-has made Earth a uniquely habitable place and provides the goods and services that sustain our lives, such as clean air and water, food and medicine, fuel, fibre, and material for constructions (Secretariat of the Convention on Biological Diversity 2005). Proper genetic resource management is a major part in biodiversity conservation. Management of genetic resources means not only conservation, which is costly and sometimes unaffordable by poor financial resources country, but also its sustainable use, research and development to get benefit from utilization of genetic resources, deriving financial gain and in the same time maintaining the availability of the genetic resources pool.

Despite the importance of biodiversity, however, biodiversity loss is rapid and ongoing. Over the last 50 years, humans have changed ecosystems faster and more extensively than in any comparable period of time in human history. Species are going extinct at rates 1,000 times the background rates typical of Earth's past. The direct causes of biodiversity losses are habitat change, overexploitation, the introduction of invasive alien species, nutrient loading and climate change show no signs of abating. Every year, between 18,000 and 55,000 species become extinct (Djoghlaf 2006).

The major role of human in the biodiversity loss is undeniable. Therefore, in the effort to mitigate biodiversity loss, public awareness has to be created in order to stimulate actions toward biodiversity conservation and proper management of genetic resources. Proper management of genetic resources comprises not only conservations but their sustainable use for humankind, including tapping their hidden potential through research and development while in the same time conserving it for the future.

Public Education and Awareness is in the Article 13 of the Convention on Biological Diversity (CBD) where:

The Contracting Parties shall:

a. Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes; and

b. Cooperate, as appropriate, with other States and international organizations in developing educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity (CBD 1992).

To implement article 13, at its sixth meeting, COP addressed Article 13 for the third time and adopted decision VI/19 on Communication, Education and Public Awareness (CEPA), adding communication to the issue of education and public awareness. Annex to the decision, is a programme of work for the Global Initiative on Communication, Education and Public Awareness (CEPA), consisting on the following three programme elements:

- Programme element 1: "Towards a global communication, education and public awareness network". Stimulating and coordinating networks composed of new information technologies and traditional communication mechanisms;
- Programme element 2: "Exchange of knowledge and expertise". Exchanging of knowledge and expertise among professionals, enhancing development and innovation on CEPA;
- Programme element 3: "Capacity building for communication, education and public awareness". Developing capacity of the Parties: for marketting biodiversity to other sectors, and mainstreaming biodiversity into the work of other sectors.

CEPA is not only to create awareness, but also how to create a change at all levels-from individuals to organizations to societies, from local to national to global. The change needed to stimulate a new attitude and stimulate actions toward sustainable management of genetic resources, not only in the environmental sectors but all sectors including industry and agriculture.

Programme element 1 is to address the necessity to network using the existing traditional communication mechanisms and means, at the same time developing more effective ways to deliver the message through new and everchanging information technologies. Programme element 2 is to address the scarcity of the expertise on CEPA and encourage cooperation between State Parties. Meanwhile, the programme element 3 is to address capacity building to communicate, educate and creating public awareness mainly how to sell the idea, to market and mainstream biodiversity and management of genetic resources to all sectors involved.

The "deep change" about the value, the vulnerability and the need to shift attitude towards a sustainable development of genetic resources places demands on communication and learning. However there are two major factors become constraints in this process. First is the reluctancy to change, especially in the non environmental sectors such as industry, and the second is the diversity of cultures. Therefore, the questions are : How people are learning about change? What methods actually lead to change? Are people communicating and learning so that people can manage change processes more effectively? Traditional perspectives of communication and education are not enough, not only in the perspective of effectiveness across cultures and disciplines but also in the perspective of time.

To create deep change, people must find ways of managing communication and learning across cultures and disciplines, and collectively creating and managing new knowledge for sustainable solutions. Change management describes a structured approach to transformation in individuals, organizations and societies, moving the target from a current to a desired state.

A few pertinent principles include: focusing on the desired change; understanding “mental models” and cultures; respecting needs and context; engaging and working with diverse stakeholders; building relationships and social capital through social networks; making accessible relevant knowledge; focusing on learning individuals and learning organizations; and ensuring consistency and congruence in “walking the talk” (Wheeler 2006)

This short paper is to address about what is CEPA and why do we need CEPA; how to get started; networking and raising awareness; engaging multiplestakeholders and mainstreaming biodiversity and planning strategic communication about CEPA.

What Is CEPA and Why Do We Need CEPA

Unsatisfied human needs agricultural production, mine production, timber, water, energy, urbanisation, construction, tourism, transport and industry causing irreversible transformation of the nature. Massive extinction of species, depletion of natural resources, ecosystems reduction and increasing threats from natural disasters are already happened and still goin on. Moreover, global warming is approaching and adding more threats to the ecosystems and genetic resources.

Benefit of the nature and of the genetic resources to the humankind is already recognized, however in poor resources countries there are always a dilemma. The need for “fast money” to feed the people and the need for conservation is always at odds. People realized that genetic resources have economic potential, however, this potential is still have to be discovered. Meanwhile, the phragmatic approach to use the natural resources for other purposes is almost always winning. One of the examples is about forest reserve and oilpalm plantation in Indonesia. Indonesia needs more and more oilpalm, especially in the event of energy crisis, because oilpalm is giving income and job to the people, while in the same time become one of the major trade commodities giving devisa needed for the country. Therefore, it is always a temptation to open more and more land for oilpalm plantation. However, uncontrolled opening of land for plantation, mining and other purposes certainly endangering the nature and depleting genetic resources.

The above conditions stress the importance of wholistic approach, not only from people from the evironmental sector, but also from other sectors, such as industry and agriculture. Conversion of the nature to get the economic benefit have to be done sustainably, taking into account the need for conservations and minimizing the negative impacts as far as possible.

Considering the above conditions, the need to mainstream biodiversity so it becomes part of economic considerations is imperative, particularly as societies undergo rapid development and populations rise.

Many countries have ratified the Convention on Biological Diversity and prepared National Biodiversity Strategies and Action Plans (NBSAPs) to conserve and sustainably use biodiversity. To implement these plans NBSAP focal points and coordinators need the cooperation of many sectors, diverse organisations, individuals and networks to address the multifarious issues affecting biodiversity and to factor biodiversity considerations into the work of those groups. Gaining this cooperation requires the strategic use of communication, education and public awareness. Effective use of CEPA requires a planned systematic approach to really understand the interests of stakeholders and beneficiaries. Approaches need to be tailor-made to the local context, culture and traditions. Nonetheless, international experiences can guide national planners in formulating country specific CEPA plans.

In several biodiversity-rich countries, the forces promoting sound genetic resource management are not consolidated and powerful enough to influence major policy decisions in favour of effective policies for sustainable use. Government agencies do not play effectively enough a leading role for genetic resource management due to:

- The lack of coordination between focal points
- The lack of political will;
- Inadequate and sometimes zero funding;
- Low technical capacities;
- Obsolete policies, and
- Mis-management of available resources.

This gap in decisive leadership by governments remains a significant impediment to achieving substantive progress in implementing good policy of genetic resource management.

Even with few resources, governments can support community education by using networks and organisations in their countries. Carefully targeted awareness and education programs can enable communities to protect and conserve the natural heritage in their immediate vicinity and on which their cultures and livelihoods depend.

The IUCN Commission on Education and Communication (IUCN 2006) expands the words associated with the CEPA acronym, to expose the range of tools and processes involved in bringing about change in people and society.

C

Communication: is about the exchange of information. It is based on establishing a dialogue between sectors and stakeholders to increase understanding of issues and to support collaborative planning and acting for the environment.

Capacity development: enhances the skills of individuals and social groups often through participatory training. It also develops the policies and procedures of organisations so that they can work more effectively for the environment.

E

Education: develops understanding, clarifies values, develops attitudes of concern for the environment and develops the motivation and skills to act for the environment.

Empowerment: develops the agency or competence to take responsibility for decision making.

P

Public Awareness: is a first step in developing understanding and concern, to help people know of the issue, to make the issue part of the public discourse or put the issue on the agenda.

Participation: allows for different knowledge to be shared in the learning process that builds people's abilities and empowers them to take responsibility and action to bring about changes for the environment.

"Participation" is used with a wide diversity of meanings. There is increasing empowerment with progress from informing stakeholders, to consultation, to consensus building, to devolved decision making, risk taking and partnerships.

Partnerships: are cooperative working relations between organisations that add value to each others' contributions in work on a project or task. Partners can contribute different skills, ideas, financial and technical support to each other.

A

Action: is required to make a change in the biodiversity condition awareness is not sufficient.

Action learning is a process designed to build capacity using reflection and assessment on the effectiveness of action taken. Other similar terms are action research, adaptive learning or adaptive management.

In short, CEPA is about mainstreaming the biodiversity to every sectors, through communication and capacity development, education and empowerment, making them aware about the importance of biodiversity and encouraging their participation into action for sustainable use of biodiversity and conservation. The most important thing to remember is public awareness itself is not enough, but education and action learning program have to be emphasized so the stakeholders may "walk the talk" and doing what they learn through the action learning program.

The implementation of CEPA in the Genetic Resource Management

Identification, communication, and coordination of the government focal points

In order to get started, first of all the focal points for genetic resource management in the government sectors have to be identified. In developing countries like Indonesia, most of the times there are several focal points involved in genetic resource management. These focal points are distributed between different sectors such as in the Department of Agriculture, Department of Marine and Fishery, Department of Forestry, meanwhile the focal points for Convention on Biological Diversity is under the Ministry of Environment. Therefore, the main problems are the lack of communications and coordinations between those focal points. The lack of communication and coordination make the effort unfocused, inefficient use of the resources and poor results. Before communication and coordination between focal points can be done, internal communications within each focal points have to be established. Other programs have to be created especially to educate the policy makers and parliament members, in order to get more commitment from the government.

Identification, communication, and coordination of the genetic resource management education

The second step after coordination between government focal points is the identification of institutions responsible for biodiversity and/or genetic resource management in education sectors. Assessments have to be done in order to understand to what extend education about the importance of genetic resource management and how to do it is done in the sector involved with formal educations starting from kindergarten through the universities. After the assesments, it is important to increase the level of education activities to give a considerable impact.

The development of coordinated programs for communication and education for communities

After the coordination of government sectors are achieved, the next step is to develop coordinated programs for communication and education for communities at all levels, starting from young people still in schools through adults in the communities. The coordinated programs will cover for example; creating education materials/tools to be use for communication and education for genetic resource management; workshops, action learning programs etc. The programs created have to involve all of the stakeholders including Non Governmental Organizations with the same interests and the local communities where the genetic resources exist in situ.

The development of coordinated programs for communication and education for other sectors

Specialized coordinated communication and education programs for other sectors especially sectors such as industry, mining, timber, tourisms, agriculture have to be created. The programs aimed at the awareness of the importance for environment and genetic resources management, and encouraging the corresponding to consider genetic resource management not as an additional cost but embedded in their program as necessity, mainly as their national responsibility.

Networking with International Institutions

One of the main constraints for this program is lack of funds and lack of knowledge. Therefore it is advisable to network and work in close cooperations with other countries and international institutions such as CBD. The CEPA program in the CBD Secretariat is one of the best choices to work with. Meanwhile, other donors are also available.

Monitoring and Evaluation

Every program has to be monitored and evaluated. Monitoring and evaluation at certain period, annual, biennial etc is an essential part of the program. It is done directly through the measurements of the results such as measurement of the level of awareness through public interview or indirectly through the measurement of other criteria e.g population of target species etc. The results of the monitoring and evaluation can be use as an input for further program.

Conclusions

The role of communication, education and public awareness for the sustainable genetic resource management is very important, especially to mainstream the genetic resource awareness to every sectors which may influence biodiversity. It can be achieved through, identification and coordination of the focal points, creating coordinated programs, networking with international institutions and monitoring annd evaluation. Lack of fund and lack of human resources can be mitigated through effective and efficient network with international institutions and other countries.

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The Establishment of Networking among Genetic Resource's Stake Holders at Provincial Level in Indonesia

Agus Nurhadi[1] and Machmud Thohari[2]

[1]National Committee on Genetic Resources, Bogor, Indonesia
E-mail: genres@indo.net.id

[2]Department of Forest Resource Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University, Indonesia; Research Center for Bioresources and Biotechnology, Bogor Agricultural University, Indonesia; and National Committee on Genetic Resources, Bogor, Indonesia
E-mail: mthohari@yahoo.co.id

Introduction

Indonesia is an archipelago laid between two continents and two oceans. She is a mega biodiversity country, team with magnitude species, animals, fishes, and plants, whose existence effortlessly support our need. It is an endless bound to full source of food.

Today, Indonesia is a home to more than 224 million people. In the year 2025 total country population can reach about 273 million people according to the Bureau of Statistic projection. We must produce more food to satisfy them. We don't know what condition will be faced in the coming decades, but we know that there likely to be hashed. Mean while rising sea levels, flood, land slide, global warming, changing weather patterns and environmental degradation will put stresses on food supplies, and make it hard to know what Indonesia will look like then. What kind of reality will our children, grand children and great grand children face, will the country be capable of producing enough food for everyone. The good news is that agriculture has an excellence track record.

Genetic resources are the raw material we use to improve the quality and output of food production. To survive and cope with the new condition we will need as much genetic diversity as possible in fish, farm animals, fruits and other crops. If we fail to conserve this diversity, we leave ourselves with a little insurance. The less diversity the fewer the option future generation will have for confronting and resolving environmental changes and new human needs.

National Strategy in Managing Genetic Resources

We need a strategy. Over time we have used thousand of species for food and agriculture. But today only about 150 plants species are cultivated. Seventy percent of our food now comes from just 12 plants and five animal species. For many major crops production has become dramatically more vulnerable with a loss of diversity within species. Loss of animal genetic diversity is equally serious. Seven thousand animal breeds are registered in a database of United Nation Food Agriculture Organization (FAO). In the past 15 years almost 200 of them became extinct. At least 60 breeds of cattle, goats, pigs, horses and poultry have been lost since 2002 alone. That is one a month on average. Since the first human abandoned hunting and gathering in favor of settle life raising crops and livestock, some ten thousands years ago, farmers have been busy improving upon nature.

They altered the original wild plants to make crops and have created diversity by adapting these crops to new ecosystem and human needs, selecting for those traits that work best. It is traditional farmers all over the world who have created and preserved agricultural genetic diversity on the ground. But the fact is, there has been modern crop variety created, farmers began to abandon traditional varieties and plant the new higher yielding ones. Farming itself change dramatically with the large scale industrial production taking the place of traditional family farms in many parts of the world. This leads and is still leading to massive permanent losses of genetic material. Thousand upon thousand of variety of grains, fruits, and vegetables disappeared virtually overnight without a plan for saving the genetic material they carried. Over time we have come to appreciate the immense value of plant genetic resources for food and agriculture and the danger of loosing them.

As the national leading body working on genetic resources, Department of Agriculture setup the national commission on genetic resources in 1976. The commission works to halt the loss of genetic diversity and make greater use of that diversity. Since inception of the commission it has negotiated and promoted good management and availability of genetic resources. This includes the establishment of 17 regional commissions on genetic resources in 15 provinces in Sumatra island, Jawa, Kalimantan, and Sulawesi island. The commission has developed information system to monitor agricultural database at the commodity based research institutes and in all regions. It has convened the first and second national congresses of regional commissions in August 2006 and June 2008 to help bring about consensus on future action plans. It has encourages of national cooperation, setting priorities and supporting network of people and institutions. This kind of collaboration brings benefit to both researchers and farmers. The commission concentrates it first on plant genetic diversity but soon it became clear that the need to protect other genetic resources was equally urgent. The goal is to provoke a national food system that works, a system that is nutritionally diverse, a system that sustainable for future generation. This is toprovoke a goal that can only be achieved by using all components of biodiversity for food and agriculture. Let's look at fishery for example, many capture fisheries today are over exploited, but aquaculture is expanding rapidly and need access to fish genetic resources. The lack of coherent policies for these resources is becoming a serious problem.

And what about forest? Good management of forest genetic resources is going to be essential, as we confronting deforestation and crouching dessert, and the growing demand for trees as sources of energy, food, and animal fodder. With plants, animals and whole ecosystem at risk, essential natural process is also threaten. Like pollination by bees and regeneration of the soil by microorganisms working underground. In other words we need an overall strategy to manage food biodiversity. First in formals crops, and animals but also forest, fisheries, and other important areas, with population increased, and climate changed, putting us on shifting sands, we need to maintain the widest portfolio of genetic resources which are vital and irreplaceable. We need to know more about the uniqueness of different species and how new environmental condition could put them at risk.

A successful strategy may require efforts on many fronts. New policies and other measures to conserve biodiversity, better education and more research, launching such a strategy now is an investment for the future. Conserving, and increasing access to genetic resources is an investment that can ensure benefit everyone. Researchers in both public and private sectors will have access to a wide range of genetic diversity. In the long run, it this can be realized, fewer people will suffer chronic hunger. More variety and better quality food will be available at the market. Food will be produced more sustain ably and future generation will have the resources to face the unknown. The Program of Work for the National Committee on Genetic Resources is a strategy for managing the country food biodiversity and a practical road map for doing just that. The exact contour of that map, are now for provincial commissions to discuss and decide.

The Sustainable Utilization Efforts on Genetic Resources

Plant breeding and research had become a true science one that build upon thousands of years development by farmers all over the world. To ensure the preservation of plant genetic material and to guarantee on going and equitable access to it by farmers, plant breeders, and researchers, a movement sprang up to established an international legal framework. In 2006, the Government of Indonesia ratified the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the first international agreement on agricultural biological diversity. In the framework of the FAO undertaking, the consultative group on international agricultural research holds in trust for the future one of the largest *ex situ* collection of plant genetic resources. More than 560,000 samples of more than 3,000 crop, forage, and pasture species are held in group of 16 centers around the world. But the greatest milestone in this long journey towards preservation and sharing came in June 2004, with the entering into force of the International Treaty on Plant Genetic Resources. Negotiated by member countries under the auspices of the FAO, the treaty is a binding international instrument that provides an agreed international framework for the conservation and sustainable use of the plant genetic resources we dependent upon for our food security. It is a major contribution to achieving food security and realizing millennium development goal number one, the elimination of extreme poverty and hunger. We all benefit in many ways, farmers and their communities through farmers right, consumers through better crop and increased food security, both public and private researchers through access to plant genetic resources crucial for research and plant breeding. The Consultative Group of International Agriculture Research (CGIAR) centers who will work within its framework and future generation, because the treaty will help conserve the genetic diversity needed to face the unpredictable environmental changes and satisfy future human needs. A unique achievement of the treaty is a multilateral system of access and benefit sharing which already covers crops that together account for 80% of human plant food of intake. These are crucial for food security, and every country and region needs them. Farmers, national research centers, universities, and plant breeders all now have guarantee access under standardize condition to the genetic material in the multilateral system they required. There is no need to negotiate hundreds of individual contracts for access. This is lower transaction cost and ultimately benefit to everyone. But that's not all, new commercial crop variety crops derived from the genetic material held under the treaty will be subject to payment mandatory or voluntary depending on the circumstances. Ease payment will be part of the treaty funding strategy which will work above all to help developing countries and countries with economic transition make us of genetic resources through capacity building, technology transfer, and information exchange and more. With these ground breaking provision, the global community source up it defense against the loss of plant genetic resources. Resources that future generation will need as they confronted the unpredictable future. In reality, the treaty is only the starting point for the work that lies ahead. Indonesia that have ratified the treaty, in today competitive international environment, has moral imperative to make it work, because these resources are the very foundation of people's lives and crucial for humanity future.

Empowerment the Genetic Resources's Stake Holders at Provincial Level

To manage sustainable (conservation and utilization) the genetic resources in Indonesia by all stake holders components, it should be done by nation wide not only done partially. To achieve the objective, public awareness should be increased by all measures. One of the activities done by the National Committee is to promote and socialize the importance of the management of genetic resources in Indonesia. By the increased of public awareness, we expected the stake holders will conserve the genetic resources in their area. Stake holders can conduct conservation activities in the area through the coordination by an institution, like regional committee on genetic resources at the provincial level.

It is important to coordinate the conservation of genetic resources at national level by establishing a national networking between the national committee and the regional committee, because through a good coordination, a well planned conservation will be well conducted. Therefore a good networking among regional committee should be established. One of the activities in networking was conducted at the first congress of Regional Committee on Genetic Resources in Balikpapan, in August 2006. This was also stressed at the second congress in Pekanbaru in June 2008.

Since 2001, the National Committee on Genetic Resources encouraged the genetic resources' stake holders at the Provincial level to establish a networking. As a result up to date there are 17 Regional Committees already established in Sumatra, Jawa, Kalimantan and Sulawesi islands. In Sumatra there are five provinces, namely South Sumatra, Lampung, Jambi, Riau, and North Sumatra already established Regional Committee. While in Jawa there are four provincial level of Regional Committee established, namely Banten, Yogyakarta, Central and East Jawa, and there are two district level of Regional Committee established, namely Tasikmalaya City and Tasikmalaya District. Whereas in Kalimantan, the Regional Committee are already established in four provincial level, namely in West, Central, East, and South Kalimantan. In Sulawesi, there are two provinces already established Regional Committee, namely South Sulawesi and South East Sulawesi Province. The other 20 provinces in Indonesia are in the process of establishing the Regional Committee in their province.

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CHALENGE AND FUTURE

Present Status and Challenge on Agricultural Microbe Bio-prospecting in Indonesia

Endang Sukara

Indonesian Institute of Sciences, Jakarta, Indonesia
E-mail: endang.sukara@lipi.go.id

Introduction

Food security is one of the essential needs which can never be ignored by any society, including in particular, Indonesia. The world population is expected to rise to around 10 billion mark by 2025. Most of the population explosion is witnessed in developing and under developed countries. It is speculated that global demand for cereals will increase from 1 billion tones to 2.7 billion tones and considering the losses in storage and processing, the real need may be about 3.4 billion tones. More people mean more food. Most of this additional demand needs to be met either by improving the crop yield or by preventing post-harvest losses. It is urgent need to intensify the agricultural practices, but at the same time must address its sustainability. Agricultural practices must be carried out without destroying the environment on which it depends. The development of such a global system for sustainable food production is one of the greatest challenges faced in the future.

Agriculture in developed and developing countries like Indonesia that follow the path of developed countries experiences already creates a range of serious environmental problems through the use of pesticides and herbicides etc. Meanwhile, agricultural production especially in many African, South American and Asian countries cannot be increased without further converting more areas into arable land, thus threatening the ecosystem and global biodiversity, which is already under stress from human action. Ecosystems are now in agony. It is characterized by erosion, low productivity, and poor water quality. This mainly caused by forest clearing, intensive agricultural practices, and continued use of land resources for purposes that are not sustainable. The biological diversity, including microbial and genetic resources losses occurred at alarming state (Kennedy and Smith 1995). The pressure also worsened since the government policy in many developing nation including Indonesia introducing a new scheme in boosting bio-energy which also requires space of land to grow Jathropa and palm oil.

A major effort in maintaining global food sufficiency is traditionally focused on the development of new crop varieties with enhanced disease and pest resistance, greater drought and salt tolerance and better nutritional value through the introduction of desirable traits either by conventional breeding or plant biotechnology including genetic modification. However, these efforts only focused on plant phenotypes. What has been largely ignored is the important role of microbial communities that interact with plants to influence plant health and productivity. The impact of the microbial world on plants is evident: worldwide each year, microbial diseases cost crop producers billions of dollar. Similarly, the important role of microbial resources in soil fertility, as bio-control agent, as bio-remediator etc., has been known for decades. What is less appreciated, and less well understood, is the pervasive influence that other microbes have on plant health and growth; they enhance stress tolerance, provide disease resistance, aid nutrient availability and uptake. Although major advances in genomic technologies and *in situ* studies of beneficial plant-microbe interactions have produced a large amount of knowledge and given insights into the mechanisms of these interactions, their application in biotechnology and agriculture has yet to be exploited. A greater understanding of how plants and soil microbes live together and benefit each other can therefore provide new strategies to improve plant productivity, while helping to protect the environment and maintain global bio-diversity (Morrissey *et al*. 2004).

Plant Microbe Interaction

The interactions of rhizosphere microbes with plants depend on the establishment of intimate associations between the two partners. Research on some of these interactions, such as those between symbiotic rhizobia and legumes, has demonstrated that this intimate cooperation between plant and bacteria displays a high level of host specificity. Different plant species, and even different cultivars of the same plant species, establish distinct microbial populations in their rhizospheres when grown in the same soil. The formation of these communities depends, at least in part, on the activation of specific gene expression in the microbe in response to chemical signals secreted from the plant. A pertinent example is the induction of nodulation genes in receptive rhizobia, which are triggered by the production and secretion of particular flavonoids by the plant. In the case of the rhizobia-legume interaction, the plant also responds to bacterial signals, and it is likely that this type of chemical cross-talk is typical of other microbe-plant interactions. Other examples of plant-derived signals that influence microbial gene expression include phenolics exuded from plant wounds, which induce expression of virulence genes in pathogenic *Agrobacterium* spp., and compounds that mimic the quorum sensing signals used by bacteria to regulate gene expression (Loh *et al.* 2002, Newton and Fray 2004). In general, however, there is only very few knowledge of signalling interactions between beneficial microbes and plants. Understanding how microbes respond to plant signals in terms of growth and gene expression, and the role that plant signalling has in determining interaction specificity or driving population selection is central to reaping the benefits of plant-microbe interactions.

Before the advent of genomic technologies, scientists had only limited options to investigate these interactions in detail, particularly with a view to their commercial exploitation. This situation has changed considerably, now that the genomes of more than ten plant associated bacteria have been sequenced, and the sequencing of another 35 relevant genomes is already under way (Puhler *et al.* 2004). A detailed investigation of the molecular basis of pathogenic, symbiotic and associative plant-microbe interactions, both at the levels of comparative and of functional genomics is now possible. So far, most data have come from comparative analyses with a particular emphasis on mutuality and pathogenic interactions. Although comparative genomics focuses on genetic potential rather than gene expression, these studies do raise some interesting questions about the distinction between pathogenic and non-pathogenic bacteria. For instance, investigations have already yielded a surprising insight regarding type-III protein secretion systems. These are ordinarily associated with pathogenicity in bacteria and are possibly also involved in non-pathogenic associations (Puhler *et al*. 2004). In the future, transcriptome profiling and functional genomics are likely to produce more information about microbial responses to plant signals and the contribution of specific gene products to the establishment of an interaction with the host. An important question is whether plant metabolites exuded from roots induce microbial type-III protein secretion systems, and, if so, how? *Pseudomonas fluorescens,* for instance, is chemotactic towards components of root exudates (de Weert *et al.* 2002), but the global effect of these exudates on gene expression in the bacterium is still unknown. By profiling the complete genetic response to root exudates, it will be possible to assemble a full picture of how gene expression, and thereby function, is modulated in the bacterium after perception of plant signals. It will facilitate studies of how different bacterial species and subspecies respond to particular plants and how a bacterium responds differentially to signals from different plant species or varieties. This, in turn, will lead to a better understanding of the basis of host specificity and host selection during microbe-plant interactions. It may also be possible to describe general principles of plant-microbe communication that define or distinguish associative, mutual and pathogenic interactions of microbes with plants. In addition to the economic effects of plant disease, microbial interaction with plants can also have serious and direct consequences for human health.

The effects of microbes on plant physiology itself have received less attention, although it is known that many food crops naturally produce toxic metabolites; potatoes and tomatoes, for example, can accumulate high levels of toxic steroidal alkaloids (Friedman 2002, Korpan *et al.* 2004). The possible role of microbes in inducing toxin production, or in modifying metabolites or metabolic pathways within the plant, remains largely unexplored. There are clear precedents for this premise, for instance the production of secondary metabolites by plants, such as phytoalexins, in response to pathogenic attack and fungal modification of plant saponins (Morrissey and Osbourn 1999, Bouarab *et al.* 2002). Although it is clearly a complex issue, the combination of plant and microbial functional genomics with metabolome analysis provides a route to start addressing these questions. Future biotechnological developments in the agricultural sector-whether based on gene modification technology or on traditional breeding-should recognize the importance of plant-microbe associations. The ‘traditional’ plant biotechnology sector is based around plant breeding and the selection of varieties with desired traits, and it pays little attention to plant-microbial ecology. But the expression of desirable traits, such as disease resistance, or drought and salt tolerance, could equally be driven by interactions between a particular plant variety and the colonizing microbial flora. Conversely, particular plant genotypes may attract a microbial flora with undesirable traits. Understanding the genetic basis of plant-microbe interactions in the context of how the plant selects its microbial population in the soil may allow ‘conditioning’ of the rhizosphere to promote desirable traits in the plant, which is, in fact, the basis of natural disease-suppressive soils. Similarly, it is also an attractive proposition to influence or modulate the microbes that interact with the plant to generate improved productivity or health for the latter. Furthermore, bacteria could be genetically engineered to confer increased disease resistance or growth promotion that is only activated when the bacterium is associated with its host plant. From the perspective of developing nations, these are exciting strategies that may help to increase yields while avoiding some of the costs and environmental problems that come with the use of fertilizers, pesticides, herbicides and fungicides. However, most of the microbial biodiversity in soil remains unexplored and much work remains to be done to first identify and then characterize microorganisms that could be used in such applications. Furthermore, such approaches require a detailed knowledge of the molecular signalling that takes place between plants and microbes to drive expression of desirable traits and suppress unwanted effects in a controlled manner. Exploiting plants and microbes by using such an integrated approach requires a systems biology strategy to understand the degree and complexity of plant-microbe interactions through the application of modern '-omics' technologies.

Modern agriculture has gone through similar phases in recent history. The first agricultural revolution in the eighteenth century introduced crop rotation to take advantage of and manipulate microbial populations in the soil, although at that time it was not known why this benefited plant health and growth. The second revolution, which began in the 1960s and is sometimes described as the 'green revolution', was based on improved plant breeding techniques and the development of hybrid varieties; it now includes genetic engineering of plants but also a heavy reliance on the use of chemicals. We may now be at the cusp of a third stage, which will combine both approaches in a more holistic and elegant strategy. Applying knowledge about beneficial plant-microbe interactions in the rhizosphere to plant-breeding and genetic-engineering technologies may allow us to increase food production while reducing stress on the environment and on global biodiversity.

Soil Fertility and Biocontrol of Plant Pathogens

Biological control of plant pathogens is currently accepted as a key practice in sustainable agriculture because it is based on the management of a natural resource, i.e. certain rhizosphere organisms, common components of ecosystems, known to develop antagonistic activities against harmful organisms (bacteria, fungi, nematodes, etc.). Arbuscular mycorrhizal (AM) associations have been shown to reduce damage caused by soil-borne plant pathogens. Although few AM isolates have been tested in this regard, some appear to be more effective than others. Furthermore, the degree of protection varies with the pathogen involved and can be modified by soil and other environmental conditions. This prophylactic ability of AM fungi could be exploited in cooperation with other rhizospheric microbial angatonists to improve plant growth and health. Despite past achievements on the application of AM in plant protection, further research is needed for a better understanding of both the ecophysiological parameters contributing to effectiveness and of the mechanisms involved. Current research based on molecular, immunological and histochemical techniques is providing new insights into these mechanisms (Azcón-Aguilar and Barea 1977).

In sustainable, low-input cropping systems the natural roles of microorganisms in maintaining soil fertility and biocontrol of plant pathogens may be more important than in conventional agriculture where their significance has been marginalized by high inputs of agrochemicals. Better understanding of the interactions between arbuscular mycorrhizal fungi and other microorganisms is necessary for the development of sustainable management of soil fertility and crop production. Many studies of the influence of mycorrhizal colonization on associated bacterial communities have been conducted, however, the mechanisms of interaction are still poorly understood. Novel approaches including PCR-based methods, stable isotope profiling, and molecular markers have begun to shed light on the activity, identity and spatiotemporal location of bacteria in the mycorrhizosphere (Johansson *et al.* 2004).

Recent study by Khan (2006) and Jing *et al*. (2007) reported that rhizobacteria adapted to heavy metal pollution would have an important vehicle in developing new strategy for bioremediation processes. Their study clearly shows that mycorrhiza could be used to improve phytoremediation of heavy metal contaminated soil.

Plant Diseases

Fungal plant diseases are one of the major concerns to agricultural production. It has been estimated that total losses as a consequence of plant diseases reach 25% of the yield in western countries and almost 50% in developing countries. Of this, one third is due to fungal infections (Bowyer 1999). So there is a pressing need to control fungal diseases that reduce the crop yield so as to ensure a steady and constant food supply to ever increasing world population. Conventional practice to overcome this problem has been the use of chemical fungicides which have adverse environmental effects causing health hazards to humans and other non-target organisms, including beneficial life forms.

Chitinases are reported to play a protective role against fungal pathogens (Boller 1985). Besides its ability to attack the fungal cell wall directly, chitinases release oligo-N-acetyl glucosamines that function as elicitors for the activation of defense-related responses in plant cells (Ren and West 1992). Studies on chitinolytic microorganisms have yielded a large increase in knowledge regarding their role in inhibition of growth of fungal plant pathogens. Moreover, extensive studies are required on the maximum utilization of chitinous wastes for production of chitinases and biomass (Gohel *et al.* 2006).

Screening of thermophilic microorganisms capable of producing chitinase was carried out from several geothermal areas in West Java Indonesia (Rahayu *et al*. 2004). More recent work is to use a molecular method for isolating chitinases from uncultivated microorganisms. Genes encoding chitinases may be particularly interesting examples of non-essential genes in uncultured bacteria since previous work has suggested that the evolution of these enzymes has been impacted by lateral gene transfer (Gracia-Vallve *et al*. 1999). Many types of cultured bacteria and archaea are known to degrade chitin but the identity of uncultured bacteria degrading chitin in nature is unknown. Chitinase genes cloned directly from uncultured marine microorganisms suggested the presence of a large pool of uncultured chitin degrading bacteria in aquatic systems. Information on bacterial chitinase genes is largely restricted to cultured γ-proteobacteria or gram positive bacteria. Since γ-proteobacteria are widespread in the ocean (Giovannoni *et al*. 2000). To access chitinase genes in uncultured β-proteobacteria and in other bacteria, it may be possible to use a PCR based approach with oligonucleotide primers patterned after conserved amino acid residues or after conserved nucleotide sequences of chitinase genes in cultured bacteria (Suitil and Kirchman 1998). Molecular methods are needed to study chitinase producers without the isolation of bacteria in pure cultures. Methods that use nucleic acid probes and PCR primers cannot be designed solely with cultured bacteria because nucleotide sequences of chitinase genes from cultured bacteria so far characterized are very different suggesting that the chitinase sequences from uncultured bacteria will differ from the culturable ones (Cottrell *et al.* 1999).

Bioactive Agents

Plants constitute an excellent ecosystem for microorganisms. The environmental conditions offered differ considerably between the highly variable aerial plant part and the more stable root system. Microbes interact with plant tissues and cells with different degrees of dependence. The most interesting from the microbial ecology point of view, however, are specific interactions developed by plant-beneficial (either non-symbiotic or symbiotic) and pathogenic microorganisms. Endophytes, microorganisms that reside in the tissues of living plants, are relatively unstudied and potential sources of novel natural products for exploitation in medicine, agriculture, and industry. It is noteworthy that, of the nearly 300,000 plant species that exist on the earth, each individual plant is host to one or more endophytes. Only a few these plants have ever been completely studied relative to their endophytic biology. Consequently, the opportunity to find new and interesting endophytic microorganisms among myriads of plants in different settings and ecosystems is great (Strobel and Daisy 2003).

Recently, a novel fungal genus that produces extremely bioactive volatile organic compounds (VOCs) is found. This fungal isolate was initially discovered as an endophyte in *Cinnamomum zeylanicum* in a botanical garden in Honduras. This endophytic fungus, *Muscodor albus*, produces a mixture of VOCs that are lethal to a wide variety of plant and human pathogenic fungi and bacteria. It is also effective against nematodes and certain insects. The mixture of VOCs has been analyzed using GC/MS and consists primarily of various alcohols, acids, esters, ketones, and lipids. Final verification of the identity of the VOCs was carried out by using artificial mixtures of the putatively identified compounds and showing that the artificial mixture possessed the identical retention times and mass spectral qualities as those of the fungal derived substances. Artificial mixtures of the VOCs nicely mimicked the biological effects of the fungal VOCs when tested against a wide range of fungal and bacterial pathogens. Potential applications for “mycofumigation” by *M. albus* are currently being investigated and include uses for treating various plant parts, and human wastes. Another promising option includes its use to replace methyl bromide fumigation as a means to control soil-borne plant diseases (Strobel 2006). Similar microbe also successfully isolated from Indonesian unidentified vine, generally used by the indigenous people of the Tesso Nilo region in Sumatra to treat snakebites (Atmosukarto *et al*. 2005). This unique organism produces a number of VOC's not previously observed in other *M. albus* isolates including tetrohydofuran, 2-methyl furan; 2-butanone; aciphyllene, and large amounts of an unusual azulene derivative. Noticeably absent from the VOC mixture was 1-butanol, 3-methyl-. Scanning electron micrographs of the organism showed a unique fishnet-like deposit of what appears to be a biopolymer covering the hyphae. The ITS-5.8S rDNA partial sequence data showed 99% identity to the original *M. albus* strain cz-620. In addition, an artificial mixture of some of the VOC's produced by this new isolate generally mimicked the inhibitory as well as lethal effects of the fungal VOC's on the test microorganisms. One of the most sensitive test fungi was *Stachybotrys chartarum*, an organism associated with the “toxic mold” syndrome of buildings. Fungi belonging to the *Muscodor* genus regularly appear in tropical rainforests throughout the world and these isolates appear to have chemical, biological, and structural characteristics that make them potentially useful in medicine, agricultural and industrial applications (Atmosukarto *et al*. 2005).

A highly potent allelopathic factor, lepidimoide, was initially extracted from mucilage of germinated cress seeds. This compound is a shoot growth promoter and inhibits root growth (stimulatory or inhibitory effects). This should be an importance to the future agriculture. An endophytic fungal strain AHU9748 belonging to the coelomycetes, closely related to the genus *Colletotrichum*, isolated from *Coleus galeatus*, demonstrate its ability to produce oligosaccharide having similar properties to lepidimoide on thin layer chromatography. The physico-chemical data from ESI-MS, NMR spectra and other analyses also showed the purified product to be identical to lepidimoide (Tanaka *et al*. 2002).

Recents Development

Low pH and aluminum tolerance of Bradyrhizobium strain isolated from acid soils in Indonesia has been studied (Takashi *et al*. 1999). The strain is evaluated for its effectiveness on various cultivar of soybean. In addition, the technique for the production of Bradyrhizobium biomass is also successfully developed. A pressure cooker fermenter is introduced for this process. It is now possible to use of such system, for the production of biomass economically event at soy bean production center as the process do not require a special laboratory. In addition, two stages fermentation system is also developed. For this purpose, cassava starch may be use as a sole source of energy for the production of Bradyrhizobium biomass.

It also important to note, that Bradyrhizobium may also be inserted directly into the soy bean seed without affecting germination. This technique could significantly improve soy bean growth and its productivity. It is predicted that Bradyrhizobium may colonize root of soy bean quite early during seed germination process. This technique shows a tremendous result as it could effectively forming root nodules, maintain the effectiveness of Bradyrhizobium in helping the soy bean plant to fix nitrogen. In addition to Bradyrhizobium, Azospirillum, independent nitrogen fixing bacteria also studied and together with *Pseudomonas* sp. and Bradyrhizobium could be inserted into soy bean seed (Sukiman and New 1990). The relationship between root colonization and the effect of inoculation on growth and productivity of soy bean continued. The experiment of injection of a mixture of microbial biomass to soy bean seed could improve the production of soy bean in limited trial at Musi Rawas with the production of between 3.8 and 4.0 ton per ha.

Intensive study also carried out on the identification of acetic acid bacteria from Indonesian sources. Study is focused on the genus of Gluconobacter (Yamada *et al*. 1999 and 2000, Katsura *et al*. 2001, Lisdiyanti *et al*. 2002). From their study, it is firmed that Indonesia rich in microbial diversity. Many new species is found and some genus including *Kozakia* and Asiana are proposed. The later is mainly isolated from flower and recently reported present in the mosquito gut. This sought by world scientific community to have an importance and significant asset for the future strategy in combating malaria.

Isolation and screening of endophytic microbes from various plant resources in Indonesia is intensively carried out since early 2000 (Michiko *et al*. 1999, Atmosukarto *et al*. 2005, Strobel 2006). A large collection of endophytic microbes is now available at Research Center for Biotechnology-Indonesian Institute of Sciences (LIPI) as materials for further study. Early screening showed a significant result toward the development of biocontrol agent and for the improving quality of soil and plant growth and productivity. In addition, an intensive exploration also carried out on fungi and actinomycetes. The number of fungi and actinomycetes deposited at Research Center for Biology and Research Center for Biotechnology LIPI now approaching 6,000 cultures. Intensive taxonomic study is being carried out. Early screening on almost 1,000 cultures by Kiohako and Chugai Pharmaceutical Company under the collaboration with LIPI and NITE (National Institute for Technology Evaluation of Japan) show promising results. Meanwhile, study on around 1,800 culture carried out by Research Center for Biotechnology found there is a change to develop anti viral agents as some 16 culture showing to produce anti helicase properties, an enzymes responsible for the proliferation of virus.

Conclusions

Indonesia has wide range of ecological habitats from Puncak Jayawijaya (covered by iced) to a deep Weber seas laid in the tropical belt between Asia and Australia. It should be a perfect habitat for diverse microbial resources with abundance of novel taxa of culturable and unculturable microorganisms of great potential value. Microorganisms of Indonesian origin should be a major source of genetic information to solve many problems in agriculture, industry, plant, animal and human health and several other biotechnological applications. The vast majority of the microbial diversity of Indonesia, however, is unexplored. It is important to Indonesia to formulate strategy in harnessing the value of microbial resources to improve the efficient and cost effectiveness in producing a diverse array of novel value-added products and tools, increase food production, reduce dependency of agriculture on chemicals, lowering the cost of raw materials, all in an environmentally friendly manner to provide solution to natural resources depletion, environmental, agricultural, food, forestry and public health towards poverty eradication and improved livelihoods of the people. It is a priority to Indonesia to continue mapping and sequencing of animal/plant/microbial genomes to elucidate gene function and regulation and to facilitate the discovery of new gens\es as a prelude to gene modification. It is also important to determine biochemical and genetic control mechanisms of metabolic pathways in animal, plants, and microbes that may lead to products with novel food, pharmaceutical, and industrial uses.

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The Challenge for the Future Agricultural Genetic Resources Management in Indonesia

Sutrisno[1] and Bambang Setiadi[2]

[1]Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, Bogor, Indonesia and National Committee on Genetic Resources, Bogor, Indonesia
E-mail: s.trisno@indo.net.id

[2]Indonesian Research Institute for Animal Production, Ciawi-Bogor, Indonesia
E-mail: b_setiadi@telkom.net

Introduction

The Convention on Biological Biodiversity define the dimensions of agricultural biodiversity as follow: Plant genetic resources for food and agriculture, including: pasture and rangeland species and forest genetic resources of trees that are an integral part of farming systems; Animal genetic resources for food and agriculture, including fishery genetic resources, in cases where fish production is part of the farming system, and insect genetic resources; Microbial and fungal genetic resources. The importance of agrobiodiversity encompasses socio-cultural, economic and environmental elements. All domesticated crops and animals result from human management of biological diversity, which is constantly responding to new challenges to maintain and increase productivity (CBD 2007).

A straight forward meaning of agricultural genetic resources (AgGR) management is the use of AgGR in sustainable manner and to conserve the existence and the diversity of AgGR. The conservation of AgGR is a must to fulfill a need of human being that always change from time to time and from generation to generation in paralell with the change of socio-culture, environment, and politic - economic. The AgGR is not only an important source of genetic material to develop new varieties, but also as source of new knoweledge, science, and technology for the benefit of human and its environment. However, the data and information on the national AgGR conservation and utilization scatter in several stakeholders. A compilation and an analysis of state of the art of national AgGR is important not only as a baseline to evaluate the future national AgGR, but also to develop a better strategy to conserve and sustanainable use of AgGR. Beside the lack of state of the art of national AgGR, Indonesia is facing to several challenges that includes: developing the national strategic priorities of action for AgGR management; improving national institutional and organization structure for AgGR management; making a national legal framework working; balancing the policy objective among policy makers with the goal maintaining AgGR diversity and environmental integrity while increasing agricultural production; anticipating the dynamic change of pests and diseases; anticipating the climate change; achieving the sustainable agriculture development; exploring the benefit and drawback of new technology.

Establishing the State of the Art of the National AgGR

The data or information on the state of the art of the national AgGR is important as a base line to monitor a progress of national effort in the AgGR management. At least four activities should be carried out to establish the state of the art of the national AgGR.

1. Compile and generate data on the national AgGR diversity (at the level of genetic, species, or agro ecosystem). I believe that several data are already exist in several stakeholders that was collected several years ago or just recently.
2. Compile and generate data on the national AgGR movement/exchange among different agro ecosystem. This is not easy task, since we are weak in the documentation. However, the rapid development on the information technology will help us in assessing the movement/exchange of AgGR.
3. Generate data on the characters of AgGR. I believe that several research institutes or other agency, according to their mandate, they have characterized certain AgGR at genetic, species or ecosystem level.

   However all data relating to national AgGR diversity, movement or exchange, characters, are still scattered. This is a challenge to compile and analyze the existing data and to fill in the gap of data for the better future AgGR management.
4. Establish a map of national AgGR. The above mentioned data will help us to develop a map of national AgGR that contain the diverse of genetic or species in every agro ecosystem in all island of Indonesia. I think, the map of national AgGR will be a landmark of the awareness of the current generation of a nation to the AgGR. It also mean that the map will be also as one of the tool for better future management of AgGR.

Developing National Strategic Priorities of Action for AgGR Management

The IBSAP (Indonesian Biodiversity Strategy and Action Plan) has been issued by the Agency for National Planning (BAPPENAS 2003). Multiyear program of work (MYPOW) on genetic resources for food and agriculture has also been adopted during the eleventh session of Commission on Genetic Resources for Food and Agriculture in 2007 (CGRFA 2007). The second session of Governing Body on the International Treaty on Plant Genetic Resources for food and Agriculture has also agreed to the several activities relating to AgGR management (ITPGRFA 2007). However, the implementation of the IBSAP at national level, especially on AgGR and the national follow up to the MYPOW and IT-PGRFA still limited.

A number of national strategies and plan of action for AgGR management may be already exist, but scattered at different agency or stakeholders. The challenge is to compile, analyze and develop a national strategy and plan of action for AgGR management.

Strengthening the Capacity in National Institution

There are several players in the field of AgGR in Indonesia, that include ministry of agriculture, ministry of environment, ministry of forestry, other ministries, several non departmental institute, and also several non government organization. Ministry of environment has been assigned as a national focal point for Convention on Biological Biodivesity**.** Ministry of agriculture has been assigned as national focal point for Genetic Resources for Food and Agriculture. National Committee on Genetic Resources has been assigned as an advisory body to the authorities, especially regarding to the agricultural genetic resources. The Provincial Committee on Germplasm has also been established at 15 provinces. However, the coordination among those body and other stake holders still need to be improved. This was due to partly by the absence of clear structure of national organization for AgGR management. The challenge is to establish a clear structure of the national organization as soon possible to manage AgGR. A well structure of national organization will lead to a better coordination among key players in the AgGR management at national level, regional level, and international organization.

Making the National Legal Framework Working

Indonesia has enacted several regulations related to AgGR management. In 2006, Law No. 4 on the Accession of International Treaty on Plant Genetic Resources for Food and Agriculture has been enacted. The objectives of the Treaty are the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity for sustainable agriculture and food security (Anonim 2006). In 2004, Law No. 21 on the Ratification of Cartagena Protocol on Bioafety to the Convention on Biological Biodiversity has lso been issued with the objective to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risk to human health, and specifically focusing on transboundary movement (Anonim 2004). In 2000, Law No. 29 on the Plant Variety Protection was enacted based on the consideration that genetic resources are a basic material for plant breeding, therefore it need to be conserved and used in a good manner to develop superior plant variety to support the development of seeds industry for the benefit of all stakeholders (Anonim 2000). In 1997, Law No. 23 on the Environment Management has been enacted with the objective to achieve the environmentally sound sustanaible development for the welfare of human beeing (Anonim 1997). In 1994, Law No. 5 on the Ratification of the United Nation Convention on Biological Biodiversity was enacted wit the objective to be pursued in accordance with its relevant provision, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefit sharing arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all right over those resources and to technologies, and by appropriate funding (Anonim 1994). In 1992, Law No. 12 on the Crops Culture System was enacted with the consideration that the diverse of natural plant resources and its importance role for human beeing are a gift of God which shall be managed and used sustainably for the welfare of human beeing (Anonim 1992). One of the objective of this Law is to increase and to widen crops diversity to meet the need of foods, clothes, houses, healths, industries, and exports. In 1995, Government Regulation No. 44 on seed of plants was enacted with one of the objective to ensure the conservation of germ plasms and its use. In 2006, Government Regulation No. 41 on the Permission to Carry out Research and Development by Foreign University, Foreign R & D Isntitutes, Foreign Companies, Foreign Persons was enacted. In 2006, Regulation of Ministry of Agriculture No. 67/Permentan/OT.140/12/2006 on the Conservation and Use of Plants Genetic Resources was enacted with the aim to conserve and use of plant genetic resources for supporting sustainable agriculture development. In 2006, Regulation of Ministry of Agriculture No. 35/Permentan/OT.140/8/2006 on the Guideline for the Conservation and Use of Livestock Genetic Resources was enacted with the objective to guide on the implementation of the conservation and use of genetic resources of indigenous and local livestocks for the sustainable development of high quality of livestock breeds.

Although several regulation have been enacted, the implementation of these regulations are still limited, due to the lack of the instruments for the implementation and the the weakness on the capacity and the lack of public awarenness. Therefore, the challenge to us is to strengthen the weakness and fill in the lack exist in the implemetation of regulations, to make all stakeholders aware of the national regulations on the conservation and use of genetic resources for food and agriculture.

Balancing Policy Objectives among Policy Makers

Increase the national agricultural production is needed with the aim: to feed the population that increase 1.4% per year; to meet consumers preference that becoming more specific due to the increase their lifestyle; to ensure food safety that will keep human healthy; to support rural development toward rural welfare; to alleviate hunger and poverty that reach around 35 million people.

However, beside the need to increase agricultural production, at the same time we also need to maintain AgGR diversity and environmental integrity. We need to maintain crops diversity at genetic or species or agroecosystem level. We need also to maintain indigenous and local breed livestock. The diverse of AgGR will be very useful source for the development new desired varieties at present and future.

The following is an example of the challenge to balance the policy among policy makers. The first example is the program to expand palm oil plantation. This expansion will need a significant land area that may now in the form of forests or peat soil. The conversion of forests will reduce diversity and the intensive exploitation of peat soil, some believe, will contribute to the global warming. The challenge will deal with the decision among the policy makers to determine where and how to expand palm oil, how to integrate palm oil with other commodities, how to regulate palm oil expansion at provinces level.

The second example is the effort to use Bali Island as *in situ* conservation for Bali's cattle. The question, do the authorities aware of the important and give support to *in situ* conservation of Bali's cattle. If so, where, whole Bali or part of Bali will be used for *in situ* conservation. What is public opinion regarding with this initiative? Does province government have regulation on this issue?

The third example is the program on promoting national food diversity. Now, the national program on food security is focusing on increase rice production five percents per year. It may develop public perception that the government will make rice only for food security and may lead to the perception that government will change the habit from eating non rice to eating rice. On the other side there is a perception of a group of people that non rice is low class food, and rice is better food, so this group will be happy to change their habit to eat the rice. Therefore the challenge will be how to promote non rice food as good as rice and as high class of food; how to balance between the program on rice production and non rice production. The success in promoting food diversity will lead to the increase in crops diversity.

The fourth example is an effort to maintain and to increase crop genetic diversity in their breeding program. The advances in science and technology give advantages to the breeders in their breeding program. Several new approaches are able to solve problems that can not be solved by conventional approach. The introgression of wild plant relative into elite line will possible by the help of embryo rescue using tissue culture. The genetic engineering will make possible the transfer of certain gene(s) into the recipients. The challenge to the breeders, do they also consider to increase genetic diversity beside of their interest to certain economic traits in their breeding program. For the livestock breeding, the challenge for the breeder will be how chose and apply a strategy in the breeding program for livestock that include the choices of indigenous and local breed, cross breed or composite breed. Therefore, the existence of indigenous and local breed shall be maintained.

Anticipating the Dynamic Change of Pests and Diseases

As a living organisms, pests and diseases change dynamically from time to time to adapt the change of their environment. Sometime (if not often) we are panic to face the emergence of new pests or diseases and this situation will lead to us to apply counter measure which show very effective at a short time regardless the worse impact of that approach will make us more trouble in the future. One of an example is the case in the outbreak of avian influenza diseases. A standard operation procedure to coupe with the incidence of avian infulenza diseases is to eradicate all avians that live at certain radius from the spot of disesases. This action may also kill indigenous and local avian that may live in that radius and the consequences may be the lost of the useful genetic resources for our future generations. The challenge for us is how to save avian genetic resources from the avian influenza control program, such as to vaccinate the local avian rather than to kill them all. Therefore the challenge to us is to choose a best approach after we consider the effectiveness, the biodiversity, the social and economic impact, and the environment integrity. Other example is the case in the outbreak of pests and diseases on rice plant. Farmers aware of the important of rice browtn planthoppers, rice bacterial leaf blight and rice blast diseases as a limiting factor in their rice production (IRRI 1977, IRRI 2004, Kartaatmadja *et al*. 1998, Kuyek 2000). The development of new race or strain or population of those pests and diseases had been epreienced in several countries. Genes for resistance to those pest and disesase have also been identified in the wild rice (Khush and Brar 2003). Therefore the challenge is intensify the exploration, conservation, characterization, and utilization the wild relative of crops.

Anticipating the Climate Change

It was believe that the intensive use of fuel and the rapid lost of of biodiversity cause exesive emission of CO_2 which lead to the global warming or the climate change. It was indicated by the increase in temperature and precipitation, rising sea level, extreme whether. These climate changes will give a great impact to the sustainable agriculture development. New varieties which can survive in the changes environment shall be made available. It will possible if the diverse of AgGR can be maintained. The challenge will be how we conserve diverse AgGR to anticipate new pests/diseases, water scarcity, flooding, salinity, and land degradation.

Achieving Sustainable Agriculture Development

It is well known that agriculture in Indonesia was developed in the diverse agro ecosystems, which include up land, low land, and tidal swamp agroecosystem. It was believed that the more diverse in the agricultural production system the more sustainable the agricultural production. Therefore, the challenge will be how to maintain the application of the wise of traditional knowledge, to generate or improve local specific technology/demand, to introduce diverse agriculture commodities; to include socio-cultural consideration in the decision-making process; to practice the participatory decision making process.

Exploring the Benefit and Drawback of New Technology

The science and technology develop rapidly, including the development of modern biotechnology. The advantage arise from the modern biotechnology can be used to conserve and utilize the AgGR. However, it was aware of the persistance of the controversy in the application of modern biotechnology. The challenges will be to assess the benefit and drawback of the biotechnology product, such as genetically engineered crops; to establish the code of conduct on biotechnology; to utilize modern biotechnology to characterize and assess the diversity of AgGR

Clossing Remark

From the national AgGR management perspective, all stakeholders are challenged to stick together in synergize and harmonize manner to assess national state of AgGR, to develop national strategic priorities of action, to improve national institution and organization structure, to strengthen legal frame work, to balance policy objective among policy makers; to achieve sustainable agriculture for sustainable welfare of human being in harmony with the environment.

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Indonesian Agency for Agricultural
Research and Development
Jalan Ragunan No. 29, Pasarminggu, Jakarta 12540
Phone: +62 21 7806202, Fax.: +62 21 7800644

ISBN 978-979-3919-08-9