Conservation and Sustainable Use of PGRFA in Indonesia  
(Konservasi dan Penggunaan Berkelanjutan SDGTPP di Indonesia)  

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ABSTRACT  

The high diverse of plant genetic resources for food and agriculture (PGRFA) in Indonesia needs to be conserved for sustainable use to achieve food security despite a still growing population. Therefore, database and information system which could add value to the PGRFA have been developed by many international initiatives and conventions which impact to national level. Two international agreements that Indonesia intensively involved to govern access and share the benefit arising from the use of the valuable PGRFA are the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Nagoya Protocol of the United Nations Convention on Biological Diversity. Agriculture development in Indonesia, however, is still faced many challenges. This review described and discussed the high biodiversity in Indonesia, utilization and conservation of PGRFA, supporting regulation and policy on PGRFA along with the progress of database and information system. Overall, promoting conservation and the sustainable use of PGRFA is a key goal of various national, regional, and global efforts, initiatives, and agreements governing them for human well-being.  

Keywords: Agro-biodiversity, Nagoya Protocol, ITPGRFA.
INTRODUCTION

Agriculture and biodiversity are linked to each other and include all components of biological diversity, which is important for food and agriculture itself. The agricultural biodiversity can potentially be utilized for human life in the future and should be conserved as plant genetic resources for food and agriculture (PGRFA). In this regard, collection, conservation, evaluation and further utilization of PGRFA have been done by not only countries but also regional and international organizations. Many countries with their own policy, manage PGRFA conservation and facilitate their use in agricultural research. The PGRFA has been utilized since the agricultural revolution, long before the concepts underlying modern genetic theory are available. The PGRFA might provide valuable breeding materials, new crop varieties, medicinal materials, and materials for research purposes (Nass et al. 2012; Pautasso 2012). Indonesia is one the richest repositories of genetic resources in the world, therefore the country is also attributable toward global biodiversity. Guardianship over the PGRFA is assumed to the best of its ability which need to be prepared on the aspect of agriculture development and economic-cost benefit.

According to environment for agriculture, Indonesia is home to the most active volcanic islands in the world as a result of its location along the “ring of fire”. Indonesia has more than 120 volcanoes, and 20 of which are considered to be the most active based on the latest data. The volcanic origin of the archipelago provided vast areas of fertile soils which support both dense tropical rainforest and agriculture. Average annual rainfall in Indonesia is roughly 3,175 millimeters, but can exceed 6,100 millimeters in the mountainous highlands. The combination of copious rainfall and fertile soils make many areas of the islands ideally suited for farming. Total agricultural land in 2016 was around 20 percent of the total land area (BPS 2019). This geographical condition allows Indonesia, being a part of Indo-Malayan Center, is a center of origin of a number of plant species such as root crops, preponderantly, some fruit crops (banana, mangostin), sugarcane and spices. Referring to Vavilov postulate that crop diversity commonly has a geographical center at which is teh highest and the center with the highest diversity of a crop is the geographical region of its origin. This concept of genetic resources diversity centers had big impact on the crop variation and the origin agriculture (Dvorak et al. 2011). As consequence, the environments in Indonesia also facilitate the country to produce main crops include, but are not limited to, rice, palm oil, cassava, coconuts, corn, rubber, mangoes, oranges, chilies, sweet potatoes, soybeans, and peanuts. However, the agricultural environment is divided largely by geography and altitude, with intensive food crop production occurring on the inner islands while less-intensive perennial cropping systems (estate crops of oil palm, sugar, rubber, cocoa, coffee, tea) predominate on the outer islands (Rada and Fuglie 2012).

Indonesia is characterized by agriculture-based civilization of long history and well known as a mega diversity country which harbors about 110,483 species of plants, consisting of 91,251 species of sporophyte and 19,232 species of spermatophyte (IBSAP 2016). This rich agro-biodiversity in this country needs conservation and management strategies. Ex situ conservation of PGRFA is rather limited by storage facilities even though it is more easy to conserve especially for short storage, in contrast to in situ conservation which needs maintenance of wild plant communities and adaptation processes. In addition, on-farm conservation might force farmers/local people to cultivate old primitive varieties. More high effort is needed to conserve of PGRFA for long storage which need more integrated facilities and effective control (Pardey et al. 2001; Sivaperuman et al. 2018). International along with national agricultural research institutes in Indonesia play an important role for the conservation type of PGRFA. However, the rise of industrialization of all forms is taken place and treathen to reduce the PGRFA diversity.

Since agriculture sector plays strategic role in Indonesian Economic Development because of its significant contribution to economic growth and
achieving food security. This sector provides food for Indonesian population which reached 255 million in 2015 with annual growth rate 1.36%, is the most urgent. Agriculture also contributes to the capital formation, industrial raw materials and bio-energy provision, work opportunities, and environmental conservation through the adoption of environmental-friendly technologies. The indirect impacts of agriculture come from its multiplier effects as the consequences of the interrelationships among industrial inputs and outputs, consumption, and investments.

Agriculture development in Indonesia, however, is still faced with many challenges. The production of some basic food sources such as rice, soybean, maize, and sugarcane should keep pace with the population growth, which expected to reach 300 million in 2020 (BPS 2019). The climate change will hamper the effort to increase food production and might endanger food security. Food production will also have to compete with production of bio-energy raw materials both in land-uses and the use of food crops as bio-fuel. On the other side, Indonesia need to use its PGRFA sustainably, as much as possible for people welfare, as stated in its constitution. This utilization of PGRFA, in some cases, requires collaboration with the technology-rich countries, which inevitably will involve exchanges of PGRFA. Thus, regulation and policy are needed to manage the PGRFA to be contributed in national and international levels. This review discussed the high biodiversity in Indonesia, utilization and conservation of PGRFA, supporting regulation and policy on PGRFA along with the progress of database and information system.

AGRO-BIODIVERSITY

Agro-biodiversity includes ecosystem, plants, animals and microorganisms related to food and agriculture. At present, most of domesticated plants and animals are resulted from human intervention like breeding and other farm practices. It consisted of three components, that are agro-ecosystem diversity, species diversity, and genetic diversity. An agro-ecosystem is an ecosystem under agricultural management (Hajjar et al. 2008). Species diversity is defined as the number of species and the richness of each species existing in a particular location. While genetic diversity is the total number of genetic characters in the genetic makeup of a species, and this review focused on plant species.

In Indonesia as archipelago, consists of two of the world’s biodiversity hotspots where a high degree of endemic species that are highly threatened by loss of habitats. Its insular characteristics and geologicak history leads to the evolution of a mega diverse flora globally. The importance of biodiversity could be seen in traditional medicine and agriculture which is deep-rooted in the society. Application of advance technology, pharmaceutical sector and economy along with environment policies become part of the biodiversity pathway in this country (von Rintelen et al. 2017).

AGRO-ECOSYSTEM

Agro-ecosystem differs from natural ecosystems in that the energy flows, nutrient budget, and biodiversity which are subject to human intervention. In fact, the human intervention in term of the choice of crops, technologies, and the farming system are the main factor that delineate one agro-ecosystem to the others. Major agro-ecosystem in Indonesia such as lowland, upland, and tidal swampland, are delineated not only based on the elevation, but also based on the methods of rice cultivation.

The lowland, is an area of land that is not very high above the sea or that is lower than most of land around it. The lowland farming systems, with rice as the single crop, provides the staple food for the ever-growing population of Indonesia. Lowland farming is a source of food, wealth and job opportunities for most of the Indonesian people living in rural areas. Irrigated lowland is the most appropriate system in terms of sustainability. High rates of fertilizer use and improved crop protection practices have contributed to the high yields of rice.
There is no statutory definition of ‘uplands’, but it is generally accepted to refer to areas of mountain, moor and heath, high ground above the upper limits of enclosed farmland, largely covered by dry and wet dwarf shrub heath species and rough grassland. Hill farms also have adjacent land in the form of semi-improved and improved grassland used in conjunction with the moorland and rough grazing. All of this land needs to be sustainably managed to safeguard the valuable biodiversity of the plants that can only thrive in these habitats. Upland farming is practiced mostly under rain-fed conditions in the outer islands, and phosphorus deficiency is usually a major constraint to crop production. Upland areas are abundant in Indonesia and have a high potential for agricultural development.

Tidal swampland is the area near the coastal region influenced by sea-tides. Swampland are classified into four types, i.e. type A is directly influenced sea-tides and flooded during spring and neap tides; type B, if they are directly influenced by sea tides but flooded only during spring tides; type C is influenced by sea-tides only through water infiltration in the soil; and type D if they are not affected by sea-tides at all. Rice is the traditional crops in tidal swampland. Other crops such as soybean, maize, and vegetables can be cultivated in type B-tidal swampland.

**SPECIES DIVERSITY**

Among the 110,483 plant species identified, the Ministry of Agriculture have determined 484 crop species under the Ministry’s supervision, of which 32 crop species will be highly prioritize on 7 food crops (rice, soybean, maize, cassava, sweet potato, mungbean, and peanut), 10 horticulture species (chilli pepper, paprika, shallot, potato, mango, citrus, banana, durian, mangosten, and salacca), and 15 estate crop species (rubber, coconut, oil palm, coffee, cocoa, cashew nut, pepper, clove, tea, jatropha, pecan, sugarcane, cotton, tobacco, patcheoli) (Kementan 2015).

**GENETIC DIVERSITY**

Genetic diversity contributes to PGRFA of plant species. This PGRFA has been exploited for crops’ improvement through breeding and domestication. The success of breeding, depends mainly on the genetic diversity as the sources of genes. Therefore, proper management of PGRFA is very important for supporting the breeding program and others utilization. PGRFA management consists of exploration, conservation, characterization, evaluation, and uses (Nass 2007). It is also supported by the database system and the policy and regulation for access, exchanges, and benefit sharing of the utilization of PGRFA.

PGRFA is under considerable threat of erosion due to climate changes, replacement of farmers varieties, land clearing, overexploitation, reduced water availability, population pressure, changing dietary, habits, environmental degradation, changing agricultural systems, overgrazing, legislation and policy, pest, diseases, and weed. Conservation of PGRFA is therefore needed to maintain genetic diversity and avoiding its loss or extinction.

Characterization and evaluation is neccessary in order for breeders, scientists, and other users of PGRFA to make the most effective use of genebank collection. Identification of accessions with desired traits will help to find potential genetic materials. Characterization data record a plant variety’s distinct and heritable features. Evaluation of data record the traits promising for crops improvement. This information can also help genebank managers to organize subset collection based on particular traits or that feature maximum diversity and shown significantly to improve the use of genebank. Thousands accession of food crops including rice, maize, soybean, and other legumes under the collection of IAARD genebank have been characterized and evaluated as targeted (Mulya et al. 2016).

**UTILIZATION OF PGRFA**

Crop improvements is the earliest technology in the history of agriculture. For centuries, farmers
domesticate and select crops for their basic need, including conserving the crops and transferring the seeds and knowledge to the next generation. The advancement in science is then made possible to transfer genes that control the desired trait from one crop to the other through crossing or molecular approaches. Modern crop varieties for the present and future food security are the result of years of crossing and selection of generally genetically uniform material. Some of these varieties have been successful adopted over large areas, however, this might have left the crop vulnerable to new pests, diseases, and climatic conditions. As a consequence, to continuously look-out for new sources of useful traits is important for new challenges.

Breeding activities in Indonesia mostly are done by research centers within the Indonesian Agency for Agricultural Research and Development (IAARD). Some universities and other research centers such as the Indonesian Institutes of Sciences (ISI) and Indonesian Atomic Energies (IAE) also have breeding activities, but their scopes and intensities are limited. Within the IAARD crops-based research centers such as Indonesian center for food crops research and development (ICOFORD), the Indonesian Center for Horticultural Crops Research and Development (ICHORD), and Indonesian Centers for Estate Crops Research and Development (ICECRD) have their own breeding program to support the program of the Ministry Agriculture on crops within their respective mandates. The Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIIOGRAD) develop the tools and methodology for improving the breeding methods as well as conducting the non-conventional breeding program in collaboration with the crop-based research centers.

The output of PGRFA utilization through breeding are new varieties of crops. In the period of 2010–2013, 72 new varieties of food crops have been released which consists of 42 varieties of rice, 18 varieties of maize, 5 varieties of soybean, 5 varieties of peanuts, 1 variety of sweet potato, and 1 variety of cassava. For horticulture crops, 91 new varieties have been released which consist of 3 varieties of potato, 4 varieties of shallot, 3 varieties of chili pepper, 1 varieties of water spinach, 1 variety of sallacca, 1 variety of papaya, and 4 varieties of ornamental crops. For estate crops, 35 varieties have been released which consists of 6 varieties of coconut, 4 varieties of clover, 1 variety of sago, 1 variety of sugar palm, 2 varieties of patchouli, 4 varieties of tabacco, 2 varieties of sunan pecan, 1 variety of vegetable pecan, 4 varieties of rosella, 2 varieties of sesame, 2 varieties of peganan, 10 varieties of menta, 2 varieties of fragrants root, 1 variety of turmeric, and 1 variety of purwoceng. These new varieties of crops have significant impact on agriculture production and their quality (Kementan 2015).

The breeding program for food crops in the period of 2015–2019 have been focused on developing rice, maize, and soybean varieties that are high yield, short maturity, tolerance to biotic and abiotic stress, and adaptive to sub-optimal land, in particular those that affected by the climate changes. In horticulture, the breeding focus are for developing varieties with short maturity, better eating quality, seedless, and better performance. With those qualities, it is expected that the horticulture crops will reduce the price volatilities and improve distribution, in particular for bulky and voluminous horticultural crops.

Estate crops consists of medicinal crops, spicy crops, palm, sweetener crops, refresher crops, and other industrial crops. Breeding for perennial industrial crops are focused on developing varieties/clones with short maturity, long productive period, resistance to pest and diseases, tolerance to abiotic stresses, high productivity, and high oil content for some crops that will produce biofuel, patcheoli oil, and palm oil, and high sugar content for sweetener crops, and good quality of fiber for fiber crops.

The increasing demand of agricultural products both in quantity and quality, and the challenges in agricultural production due to the climate changes, prompted the need for more effective and efficient crops breeding. Conventional methods of breeding by means of selection based on phenotypic traits neither efficient nor effective. Development in molecular
biology and biotechnology give the opportunity to apply and implement the more efficient and effective breeding methods.

In addition to legal measure, application of biotechnology in improving the utilization and conservation of PGRFA is important. The use of genome sequencing has the potential to face some of the challenges that limit sustainable utilization of PGRFA. The actual and potential application of these genomic approaches could be addressed in plant identification, phylogenetic analysis, genetic value analysis of germplasm, and facilitating germplasm selection in genebanks as well as instilling confidence in international germplasm exchange system (McCouch et al. 2012; Treuren and van Hintum 2014; Wambugu et al. 2018). This genome resequencing and genome wide genotyping have been applied in the collection of plant accessions in IAARD, such as rice, soybean, maize, chili, potato, banana, jatropha, cocoa, oil palm, and sugar palm.

The rapid progress in in vitro culture and molecular biology is expected to assist both conservation and utilization of PGRFA (Joshi 2017), such as conservation in vitro, production of disease-free material and safe exchange, gene identification using molecular techniques, and transfer of desirable genes from the useful PGR accessions. Moreover, crops improvement is a part of main goals of PGRFA utilization and can be done by base broading of genetic variation through in vitro techniques such as somaclonal variation, protoplast fusion anther culture, somatic hybridization, genes or its promoter inclusion, and genome editing in the genes. Those technique become common in the IAARD for improved varieties. Under ICABIOGRAD lead, in addition to the invention of marker kit for early detection of sugar palm maturity, molecular markers for selection of rice eating quality, and Tenera seedling of oil palm are in progress. It will also shorthened the breeding cycles by combining the crossing methods and tissue culture techniques both for rescuing the embryo as well as for haploidization in order to speed up the process of obtaining homozygotes plant. Marker assisted selection will increase the accuracy and the efficiency of breeding cycle.

**PGRFA CONSERVATION**

**In situ and On-farm Conservation**

*In situ* approach comprise the setting and management of protective areas, such as nature reserves, wildlife sanctuaries, national parks, natural recreation parks, protected forests, river boundaries, germplasm areas, and peat areas. In forestry and agriculture sector, the *in situ* approach is also used to protect the genetic diversity of plants in the original habitat and in determination of protected species without specifying their habitats (Kusmana and Hikmat 2015). Until 2005, there are 534 units of conservation areas covering an area of more or less 28 million hectares in Indonesia. Terrestrial conservation areas reached 495 units (80.33%) while the marine conservation areas reached 39 units (19.67%). About 57.94% of the total conservation areas are national parks (FAO 2013; de Forest et al. 2013).

*In situ* may include *on-farm* conservation, i.e., conservation of plant PGRFA at farmers field with traditional farming system. *On-farm* conservation are done when the crops are spread over in large areas with many farmers. Farmers in South Kalimantan conserved some local varieties of species of Mangifera in *situ* or on *farm* (ICHORD 2016). For example, Kasturi (Mangifera casturi Delmiana) was conserved in *situ* because of its high price during the harvest season and its valuable services to environment. In Telaga Langsat village of Hulu Sungai Selatan District of South Kalimantan, people revered many of trees, including Kasturi and Kuini (Mangifera odorata), in their village and surrounding buffer forest (Shapit et al. 2013). The informal rules and beliefs protected those trees from felling. The district government and the community has developed a new informal village regulation that enforce by village protection group that limit the felling of the trees, to support the old beliefs and tradition which has been eroded due to the value of the timber that motivate to fell the trees. This is an example where
[Text content]

Table 1. Number of PGRFA collection at research centers within IAARD.

| Crops                        | Research centers/institutes |
|------------------------------|-----------------------------|
|                              | ICABIOGRAD | ICCR | ILETRI | IMRI | IVEGRI | IOCRI | IFRI | ICRI |
| Rice                         | 4,116       | 2,939 | -      | -    | -      | -     | -    | -    |
| Wild rice                    | 94          | -    | -      | -    | -      | -     | -    | -    |
| Wheat                        | 83          | -    | -      | 441  | -      | -     | -    | -    |
| Maize                        | 1,052       | -    | -      | 441  | -      | -     | -    | -    |
| Sorghum                      | 246         | -    | -      | 441  | -      | -     | -    | -    |
| Soybean                      | 888         | -    | 1,072  | -    | -      | -     | -    | -    |
| Peanut                       | 821         | -    | 179    | -    | -      | -     | -    | -    |
| Mungbean                     | 915         | -    | 1,052  | -    | -      | -     | -    | -    |
| Minor legumes                | 179         | -    | -      | -    | -      | -     | -    | -    |
| Cassava                      | 556         | -    | 310    | -    | -      | -     | -    | -    |
| Sweet potato                 | 1,364       | -    | 218    | -    | -      | -     | -    | -    |
| Taro                         | 257         | -    | -      | -    | -      | -     | -    | -    |
| Minor tubers                 | 276         | -    | -      | -    | -      | -     | -    | -    |
| Vegetables                   | -           | -    | -      | -    | 286    | -     | -    | -    |
| Ornamental                   | -           | -    | -      | -    | -      | 373   | -    | -    |
| Fruits                       | -           | -    | -      | -    | -      | -     | 1,040| -    |
| Citrus and subtropical fruits| -           | -    | -      | -    | -      | -     | -    | 163  |

Sources: ICABIOGRAD (2015); ICHORD (2016); ICOFORD (2016).

A community regulation will motivate the in situ conservation of fruit tree.

Within the Ministry of Agriculture, in situ and on-farm conservation are supervised by the Assessment Institute for Agriculture Technology (AIAT) in each province in Indonesia. A consortium for the inventory, conservation, characterization, and database management of local PGRFA have been established since 2012 involving several research centers and research institutes within the IAARD. The main players of this consortium are the AIATs which do most of the field work and the ICABIOGRAD coordinate the activities and give technical supervision to the AIATs. Additionally, these activities include supervising the in situ conservation of local PGRFA as well as inventoring institutions, organizations, and communities’ group that conduct PGRFA conservation.

Ex situ Conservation

Ex situ conservation is conservation of PGRFA outside their natural habitat. It may consist of a series of activities such as collection, characterization, and evaluation as well as maintenance and database management. The purposes of ex situ conservation are for security, exchanges, and future use of the PGRFA. It requires a good storage facilities and therefore more expensive than the in situ conservation (Pardey et al. 2001). Considering the high cost and the technologies needed, the PGRFA conserved ex situ should be limited to those that endangered of lost or potentially contain valuable traits especially local variety or wild relatives of crops.

Within the Ministry of Agriculture, ex situ conservation of PGRFA is managed by the ICABIOGRAD. Commodity-based research center within IAARD have also their own collection for their mandate. Table 1 present the list of crops and the number of accessions collected by research centers within IAARD.

The ex situ conservation methods varied among institutions according to the physiological characters of the crops. Crops with orthodox seeds conserved in short and medium terms storage, while those with recalcitrant seeds and vegetatively propagated need to be conserved in field or in vitro. In vitro and cryopreservation are alternatives method for conserving crops with recalcitrant seeds or vegetatively propagated. This method of conservation needs large investment and to develop protocol for each crop.

Other government organizations also have activities for ex situ conservation of PGRFA within their respective mandates. The Ministry of Forestry
and Environment maintains their plant collections, especially for economically important timber trees. The Forestry Research Center, has 33 forests for research which in total covers 37,000 ha area that conserve 234 species of trees (136 genera, 50 families) of which 167 species are local and 67 are exotic species (FAO 2013; FORDA 2016). Ministry of Health has 13 hectares area for ex situ conservation of 850 species of medicinal plants in Tawangmangu garden, Central Java. The center for Science and Technology Development (Puspitek) Serpong, Banten has 350 hectares of for conserving 160,020 number of specimen from 37 families; 378 genera, and 602 species (FAO 2013).

The Indonesian Institute of Sciences (IIS) manage four Botanical Gardens in Bogor, Cibodas, Purwodadi, and Eka Karya-Bali. The Bogor Botanical Gardens conserves plants from lowland humid areas, the Cibodas Botanical Garden conserving plants from the highland humid areas, the Purwodadi Botanical Garden conserve plants from lowland dry areas; and the Eka Karya Bali Botanical Garden conserves plants from highland areas of the eastern part of Indonesia. The number of collections of these 4 botanical gardens are listed in Table 2. In addition, the Research Center for Biology of the IIS, has also established a Biology Garden in Wamena in 1995 (Rahmansyah and Latupapua 2003), which became 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, which conserved 2,250 accession from 108 cultivars of 16 species fruit trees. This garden also has 360 accession of cassava (120 genotypes), 710 accessions of taro (182 genotypes), 693 accession of multipurpose trees from 10 species, and 43 accession of Jatropha curcas.

Some local governments, under the supervision of the IIS, have also constructed botanical garden based on specific theme or priority of plants, which are relevant to the international way (GSPC 2002). The Sungai Wain Botanic Garden in Balikpapan, East Kalimantan focusing on timber trees, nepenthes, and orchids. Enrekang Botanical Garden in South Sulawesi focusing on Wallace plants (Conservation International 2007; Hadiah 2011). Bukit Sari Botanic Gardens in Jambi is the remaining lowland forest among oil palm plantations. This garden was established in 2003, the area is 300 hectares and about 400 species were found in that garden. Batu Raden Botanical Garden in Central Java will conserve Javanese flora. This garden was established in 2004, the area is 142.2 hectares and 107 species has been planted in that garden. Kuningan Botanical Garden represent Ceremai mountain flora and plants adaptable to stony areas. Liwa Botanical Garden in West Lampung focusing on ornamental plants and plants from South Bukit Barisan. Katingan Botanical Gardens in Central Kalimantan focusing on fruit trees and Puca Botanical Gardens in Maros, South Sulawesi focusing on economic plants collections.

**Regulation and Policy on PGRFA**

Acknowledging the interdependence on plant PGRFA, Indonesia engages in many international agreements on exchanges of PGRFA and the benefit arising from their uses. Although Indonesia is a PGRFA-rich country, it still needs PGRFA of non-indigenous crops from other countries. National dependence on non-indigenous crops has increased over the past 50 years as countries’ food systems have become more diverse and at the same

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**Table 2. Number of collection at botanical gardens within the Indonesian Institute of Sciences.**

| Botanical garden | Families | Genera | Species | Specimen | Major plants |
|-----------------|----------|--------|---------|----------|--------------|
| Bogor           | 218      | 1,227  | 3,301   | 13,061   | Palms, orchids, medicinal plants, ornamental, shrubs and trees, aquatic plants, climbers, fruit trees |
| Cibodas         | 243      | 886    | 2,044   | 9,814    | Fern, bryophytes, cacti, orchids, rhododendrons, gymnosperms, cinchona |
| Purwodadi       | 178      | 965    | 2,014   | 11,720   | Succulent, orchids, mango, banana, medicinal plants |
| Eka Karya Bali  | 242      | 1,078  | 2,403   | 21,502   | Cacti, begonias, bamboo, medicinal plants, orchid |

Sources: www.krbogor.lipi.go.id; www.krcibodas.lipi.go.id; www.krpurwodadi.lipi.go.id; www.kralip.nlipi.go.id; FAO (2013).
time more homogeneous worldwide (Khoury et al. 2014).

Two international agreements that Indonesia intensively involved are ITPGRFA and the Nagoya Protocol of the United Nations Convention on Biological Diversity. The ITPGRFA mostly deals with multilateral system of Access and Benefit Sharing (ABS) of plant PGRFA, while the Nagoya protocol provides rule for bilateral system of ABS for all PGRFA, except human PGRFA (ITPGRFA 2009; Sabran 2018).

Transparent legislation for effective implementation of the two international agreements is important. Indonesia generated two ratifications for the implementation of ITPGRFA and Nagoya protocol, however there is no national law governing genetic resources other than the ratifications. The lack of national law regulating PGRFA led difficulties in their implementation. Fortunately, a new law has been established in 2018 about Access to Genetic Resources of Wild Species and on their Utilization which is indeed useful to support Nagoya protocol implementation in Indonesia. However, since there is no specific law to protect and access of PGRFA in Indonesia, drafting a new law is very urgent to be proceeded. A number of available national legislations that could be referred as supporting information related to the two agreement are as follows:

- Ministry of Agriculture Regulation No. 15/2009 on Procedure for Drafting MTA
- Ministry of Agriculture Regulation No. 37/2011 on Conservation and Use of PGR
- Ministry of Agriculture Regulation No. 15/2017 on Import and Export of Horticultural Seed
- Law No 11/2013 on Ratification of Nagoya Protocol on Access to GR and The Fair and Equitable Sharing of Benefits Arising from Their Utilization to The Convention on Biological Diversity
- Law No 39/2014 on Estate Crop
- Government Regulation No 13/2014 on Name, Registration and Use of Varieties in Breeding for Essential Varieties
- Ministry of Agriculture Regulation No 15/ 2009 on Procedure for Drafting MTA
- Ministry of Agriculture Regulation No 37/ 2011 on Conservation and use of PGR
- Ministry of Agriculture Regulation No 40/2017 on Plant Variety Release
- Ministry of Environment and Forestry P2/2018 on Access to Genetic Resources of Wild Species and on their Utilization

**The ITPGRFA**

The ITPGRFA/Treaty was adopted by the FAO conference in 2006 after seven years of negotiation. The Secretariat of the Treaty hosted by the FAO. Currently, there are 146 contracting parties of the Treaty. Indonesia ratified the Treaty in 2006 through the National Law No. 4/2006. The Director of ICABIOGRAD, ex-officio, is the National Focal Point of the Treaty in Indonesia.

The main objective of the Treaty is conservation and sustainable use of PGRFA. The Treaty recognizes the sovereign rights of contracting parties over their own OGRFA. In the exercise of such rights, the contracting parties agreed to establish a Multilateral System (MLS) of Access and Benefit Sharing (ABS) of PGRFA, which is efficient, effective, and transparent, both to facilitate access to PGRFA, and to share the benefits arising from the utilization of these resources in a fair and equitable way.

The MLS covers the PGRFA listed in Annex I of the Treaty that was established according to criteria of food security and interdependence and shall include all PGRFA in the list under the management and control of the contracting parties and in the public domain. The MLS also include the PGRFA in Annex I which are held in the *ex situ* collections of the International Agricultural Research Center of the Consultative Group on International Agricultural Research ( CGIAR), and in other international institutions. Multilateral in this context means that a global pool of PGRFA are shared and managed jointly by all contracting parties of the Treaty. The Standard Material Transfer Agreement (sMTA) that has been multilaterally agreed as the standard private law contract to be used for the exchange of material from the Multilateral System reconciles the global
nature of PGRFA. Since the ITPGRFA practice the principle of benefit sharing when accessing PGRFA, in 2010 started to provide financial support to farmers and local and indigenous communities conserving valuable PGRFA.

The Nagoya Protocol

The Nagoya Protocol on Access to PGRFA, and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) is a supplementary agreement to the Convention on Biological Diversity (CBD). The Nagoya Protocol on ABS was adopted on 29 October 2010 in Nagoya, Japan and entered into force on 12 October 2014, 90 days after the deposit of the fiftieth instrument of ratification. Its objective is the fair and equitable sharing of benefits arising from the utilization of PGRFA, thereby contributing to the conservation and sustainable use of biodiversity. Indonesia ratified the protocol through Nasional Legislation No. 11/2013.

The Nagoya Protocol create greater legal certainty and transparency for both providers and users of PGRFA for the effective implementation of one of the three objectives of the CBD by establishing more predictable conditions for accessing to PGRFA and assisting to ensure benefit-sharing of exchanged PGRFA. It also covers traditional knowledge (TK) associated with PGRFA that are covered by the CBD and the benefits arising from its utilization. The Protocol sets out core obligations for its contracting parties to take measures in relation to access to PGRFA, benefit-sharing, and compliance. It also creates incentives to conserve and sustainably use PGRFA and therefore enhances the contribution of biodiversity to development and human well-being (UN-CBD 2011; Morgera et al. 2015).

National Legislation on PGRFA

There is no national law that governs the PGRFA, other than the ratification of the ITPGRFA and the Nagoya Protocol. There was a proposal to revise Law No. 5/1995 on Ecosystem and Biological Resources Protection, by inserting provisions on PGRFA. This proposal, however, invites many criticisms of the draft law and domination of taught that the PGRFA need to be protected rather than being used sustainably.

The lack of national law that govern PGRFA creates difficulties in the implementation of the Nagoya Protocol on Access and Benefit Sharing which require a competent authority as the entry point for negotiating the agreement on access and benefit sharing for all available PGRFA. At lower legal hierarchy, several Ministry establish Ministerial Regulation that generated from the two ratification or other law within their respective mandates. The Ministry of Agriculture for example Ministerial Regulation No. 37/2011 which regulates the permit to export and import of PGRFA for researches and the permit to explore PGRFA in the country and Ministry Regulation No. 15/2010 that provide guidance for genetic material transfer agreements. Those regulation only valid for PGRFA as it is within the mandates of the Ministry of Agriculture. Reference for this Ministerial Regulation are the Law on ITPGRFA Ratification (Law No. 4/2016) and the National Seed Law and the Law on Plant Variety Protection (Law No. 29/2000).

Database and Information System

Information system will add value to the PGRFA. The global information system on PGRFA have been developed by many initiatives and conventions. The IAARD established genebank for core collection at the ICABIOGRAD, which is designed to be the National genebank for PGRFA, while the crop specific collection as well as the working collection are managed by crop based on research centers (sub-genebanks). In order to manage the agricultural PGRFA data, a database system has been developed since 2000 namely the Agricultural PGRFA Information System (AGRIS). This database system is used for internal purposes in order to manage data related to the genebank operational management. The data managed in the database include passport data such as provenance; management of germplasm (storage) data, such as seed viability test, seed health, storage location, and seed stock; phenotypic characterization data; evaluation data, including
resistance to pests and diseases, tolerance to abiotic stresses, as well as nutritional quality data; and their distribution, such as users who requested the accessions, accessions requested/distributed, purposes of uses, etc. Furthermore, inventoring local PGRFA in all province in Indonesia spread over various agro-ecosystem was managed in database including its mapping all over the country which can be accessed online at www.bbsdplp.litbang.pertanian.go.id/sdgp/. The states and distribution of PGRFA are regularly monitored through this website. Additionally, in order to add their value of important PGRFA for crop improvement and other research purposes, some potential genetic materials have been sequenced their genome and managed in the IAARD genomic database (www.genom.litbang.pertanian.go.id) which is kept update.

To complement the information system on Ministry of Agriculture, the IIS is now developing the Indonesian Biodiversity Information Facility (InaBIF) which is the hub of the Global Biodiversity Information Facility (GBIF). The InaBIF will be linked to the database system in the Ministry of Agriculture (AGRIS), Ministry of Forestry and Environment, Ministry of Marine and Fisheries, and the Provincial Government, in particular Local Botanical Garden. The InaBIF has wider scope than the AGRIS to cover the species and ecosystem as well as PGRFA (IBSAP 2016).

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