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Results of Biodiversity Policy in Vietnam: Conservation and Exploration of Plant Genetic Resources

PhD. Vu Dang Toan (Plant Resources Center, Ha Noi, Viet Nam)*,
PhD. Dao The Anh (VAAS)

* Corresponding author, E-mail: toanvd.prc@mard.gov.vn

ABSTRACT

Plant resources conservation plays an important role in providing resources for many important economic sectors of Vietnam. In the national genebank system, 37,820 accessions were collected both nationally (36,324 accessions) and internationally (1,496 exotic accessions). In total, 38,338 accessions of 430 species have been maintained safely in seed, field and in-vitro collections of the national genebank system. On-farm or in-situ conservation was carried out by the different international projects for 67 endemic crops from different provinces. In total, 44,116 accessions have been evaluated for agronomic characteristics by the International Plant Genetic Resources Institute (IPGRI) description guide. In total, 27,169 accessions were evaluated for quality, biotic or abiotic stresses (salinity or drought tolerance, pests or diseases resistance) genetic diversity or sub-species classification. There were 52,888 modules of passport data, 52,113 modules of characterized and evaluated data and 93,732 digital pictures of germplasm. The national genebank system provided 7,038 accessions for research and education purposes. More than 100 varieties have been selected and developed from local germplasm.

Keywords: plant genetic resources, conservation and development

INTRODUCTION

Vietnam has been recognized as one of the world's most prosperous, rich and diverse countries in terms of plant genetic resources (PGR). Diverse climatic conditions diversified the country's flora with both tropical and temperate plants. In addition, thousands of years of agricultural practice by 54 ethnic groups largely enriched its crop genetic resources with great numbers of local cultivars and land races. Vietnam is the origin centers of various crops, such as rice, taro, banana, jack fruit, mango, coconut, tea, local anion and some citrus and their crops wild relatives with agricultural and social values (Nguyen & Luu 2002).

There are more than 800 plant species grown for food, medicine and construction in largely diversified agro-systems throughout the country, including 41 starchy foods, 95 non-starchy foods, 105 fruits, 55 vegetables, 44 oils, 16 fibers, 12 beverages, 181 medicinal, 39 spices, 29 cover and bare hill re-greening, 50 ornamentals, 49 woody and 5 shadings (Nguyen 2000; Pham & Luu 2008). Recently, agricultural crops have been divided into three main groups : 1) local varieties, specialty and traditional varieties; 2) new varieties created by breeding; and 3) imported varieties .

Vietnam is richly endowed with plant genetic resources, particularly for rice, taro and banana resources. This unique genetic reservoir provides the foundation for further development and improvement of rice, root crops and banana worldwide. Traditional agricultural practices have assisted to maintain native species. With the long history of rice cultivation, the Vietnamese have accumulated a rich and indigenous knowledge for use and management of rice resources. Rice varieties are grown for different purposes and under different systems. Similarly, farmers have maintained various taro varieties for preferred traits and use.

Currently, the Vietnamese government has initiated and oriented the development of a green and sustainable economy. However, the reality development shows that Vietnam's economy has grown rapidly, bringing many socio-economic benefits and also putting pressure on conservation of plant resources. Moreover, the population in Vietnam reached over 90 million years in 2015, making Vietnam one of the most populous countries in Asia, which creates a great demand for bio-resource consumption as well as land use. Besides, the global context also poses new challenges and opportunities: the degree of climate change becomes more serious and the increasing negative effects on the conservation of plant resources. Therefore, conservation and sustainable exploitation and utilization of plant genetic resources becomes more urgent.

PLANT GENETIC RESOURCES CONSERVATION

Collection of plant genetic resources

Since early 1990s, collecting of plant germplasms in Vietnam such as rice, banana, cassava, sweet potato, yam, taro, and citrus has been undertaken through different national and international projects. Exotic germplasms have also been introduced from other countries and organizations such as Russia, Indian, China, Germany, CIP, AVRDC and IRRI. In total, 37,820 accessions of 430 species have been collected in Vietnam (36,324), and from other countries and organizations (1,496). We have divided the collection into different collected periods. The collected germplasms in Viet Nam at the periods of before 1996, 1996-2000, 2001-2005, 2006-2010, 2011-2015 and 2016-now were 8,175, 5,325, 6,500, 5,174, 11,000 and 150 accessions, respectively. The exotic germplasms at the periods before 1996, 1996-2000, 2001-2005, 2006-2010, 2011-2015 and 2016-now were 970, 20, 185, 321, 190, and 0 accessions, respectively (Table 1). The fund sources for germplasm collection were from national and international projects (Nguyen & Luu 2002).

Table 1. Collection of germplasm at Plant Resources Center and Network members

Collection period	Viet Nam germplasm	Exotic germplasm	Total
Before 1996	8,175	970	9,145
1996-2000	5,325	20	5,345
2001-2005	6,500	185	6,685
2006-2010 IV	5,174	321	5,495
2011-2015	11,000	190	11,190
2016-now	150	0	150
Total	36,324	1,496	37,820

Sources: Plant Genetic Resources for Food and Agriculture, annual project report from 2006 to 2019

Germplasm conservation

Agricultural germplasm has been conserved at Plant Resources Center (PRC) and network members by both *ex-situ* and *in-situ* conservation methods.

- *Ex-situ conservation*

In total, 38,338 accessions are conserved at PRC and network members of which more than 26,000 accessions of 120 species are conserved at seed bank with short, medium and long-term conditions, including graminaceous collection (11,356 accessions), vegetables, spice collection (8,859 accessions) and legumes collection (6,296).

Moreover, field collections are conserving tuber crop collection with 3,570 accessions, fruit and industrial crop collection with 7,633 accessions belong to 310 species (Table 2), mushroom collections 78 accessions, flower collection 434 accession, forage and land recovering crop collection with 102 accessions. *In-vitro* genebank are conserving 157 accessions of taro and 7 stevia collection. Some germplasms have been duplicated at PRC and network members.

- *In-situ/on-farm conservation*

In situ/on-farm conservation plays an important role in improving the crop genetic and it is part of conservation and management of plant genetic resources for food and agriculture in Vietnam.

In Vietnam, *in-situ* conservation has been implemented by Plant Resources Center since 2010. The purposes are to conserve endemic crops in special regions of the country. *In-situ* conservation of 67

endemic crops have been done such as local pomelo, litchi, local vegetable germplasm in Hung Yen, Ha Noi, Ninh Binh, Nam Dinh, Lang Son provinces (Luu *et al.*, 2004; Vu *et al.*, 2011).

Table 2. List of agriculture germplasm conservation at PRC and network members

No.	Crop genetic	Sources	Total	Conservation methods*
1	Graminaceous	Local and exotic	11,356	Ex-situ, ADN
2	Vegetables, spice and mushroom	Local and exotic	8,947	Ex-situ, in-vitro
3	Fruits, industrial crops	Local and exotic	7,633	
4	Tuber crops	Local and exotic	3,570	Ex-situ, in-situ, ADN
5	Legumes	Local and exotic	6,296	Ex-situ, in-vitro
6	Flowers	Local and exotic	434	Ex-situ
7	Soil improvement and forage crops	Local	102	Ex-situ, in-vitro
				Ex-situ
	Total		38.338	

* Some germplasms have been duplicated at PRC and network members

Sources: *Plant Genetic Resources for Food and Agriculture report, annual project report, 2019*

Germplasm characterization and evaluation

Characterization and evaluation of plant genetic resources are to eliminate duplicated accessions, establish core collections and discover useful genetic for selection and breeding.

The description and evaluation criteria for each crop are to be used for all member in the national PGR network. Total, 44,116 accessions have been evaluated for agronomic characteristics, and 27,169 accessions were evaluated for quality, salinity or drought tolerance, pests or diseases resistance, genetic diversity or sub-species classification. Until 2006, 12,908 accessions were characterized, 10,400 accessions for more than ten morphological traits. 7,000 accessions were evaluated for pests and diseases resistance. DNA analysis were carried out for 320 accessions of citrus and mango. Genetic diversity were evaluated for several accessions of local rice “Tam thom”, bean “dau nho nhe” and *Cucurbita sp.* From 2007 to 2010, 11,230 accessions (77.9%) were characterized, and 10,380 accessions (72%) were characterized for more than ten morphological traits. 12,044 accessions were evaluated, including 420 rice accessions for quality (amylose content, gelatinisation temperature, flavour and aroma), 6,000 rice accessions for sub-species classification, and 389 accessions (rice, taro and bean) for genetic diversity. From 2011 to 2015, total 18,336 accessions were characterized for morphological traits. 6,321 accessions were evaluated, including 2,765 accessions for quality, 1,366 accessions for salinity or drought tolerance, 1,190 accessions for pests or diseases resistance, and 1,000 accessions for genetic diversity. From 2016 until now, 1,642 accessions were characterized morphological traits. 1,484 accessions were evaluated, including 380 accessions for quality, 492 accessions for salinity or drought tolerance, 552 accessions for pests or diseases resistance, and 60 accessions for genetic diversity (Table 3).

Table 3. Germplasm characterization and evaluation

No.	Characteristic	No. of accessions*				Total
		Until 2006	2007-2010	2011-2015	2016 now	
A	Morphological characterization	12,908	11,230	18,336	1,642	44,116
B	Evaluation	7,320	12,044	6,321	1,484	27,169
1	Quality		420	2,765	380	3,565
2	salinity, drought tolerance			1,366	492	1,858
3	pests and diseases resistance	7,000	5,226	1,190	552	13,968
4	genetic diversity	320	398	1,000	60	1,778
5	Sub-species classification: rice		6,000			6,000

* Several accessions were characterized or evaluated twice or more

Sources: *Plant Genetic Resources for Food and Agriculture, annual project report from 2006 to 2019*,

PGR information and data management

The software for data management has been developed as GB2.5 software for managing the data at the national genebank. Moreover, the database has been updated in the Website as <http://www/prc.org.vn> for users.

Passport, characterization and evaluation data has been imported in the GB2.5 software. Currently, 52,888 modules of passport data; 36,777 modules of morphological characteristic data, 15,336 modules of evaluation data have been updated in the GB2.5 software. The morphological characteristic data, evaluation data and digital pictures of germplasm and passport data updated until 2006 were 12,514, 7,000, 3,500 and 8,561 modules, respectively. In 2007-2010, the morphological characteristic data, evaluation data and digital pictures of germplasm and passport data were 10,380, 5,226, 0, 20,001 modules, respectively. At the period 2011-2015 the morphological characteristic data, evaluation data and digital pictures of germplasm and passport data were 11,880, 1,930, 46,632 and 19,133 modules, respectively. In 2016-now the morphological characteristic data, evaluation data and digital pictures of germplasm and passport data were 2,003, 1,480, 18,250, 93 modules, respectively (Table 4).

Table 4. The plant genetic resource data was imported at National Genebank

TT	Data	Digital modules				Total
		Until 2006	2007-2010	2011-2015	2016 now	
1	Morphological characteristics	12.514	10.380	11.880	2.003	36.777
2	Evaluation	7.000	5.226	1.930	1.480	15.336
3	Digital pictures of germplasm	3.500	0	46.632	18.250	93.732
4	Passport	8.561	20.001	19.133	93	52.888

Sources: *Plant Genetic Resources for Food and Agriculture, annual project report from 2006 to 2019*

EXPLORATION

In national and local research institutions, biotechnology and traditional methods have been used in crop improvement. More than 1,000 accessions from *ex situ* collections have been provided for selection and breeding purposes every year (Le, La & Tran 2013; Pham & Luu 2008). As a result, more than 160 new commercial varieties originated from the national PGR system have been developed and recognized nationally. A number of local promising lines or varieties have been recovered, propagated and reintroduced to agricultural production. Until 2006, 11 local promising lines/ varieties were reintroduced to farmers, including 3 rice, 4 taro, 1 vegetable, 1 bean and 2 flower. From 2010 to 2013, 61 local promising lines/ varieties were reintroduced to farmers, including 17 rice, 4 maize, 5 taro and 11 fruit (orange, mandarin, grapefruit and persimmon), 3 vegetable, 21 industrial crops (MOST, 2013).

To protect local promising lines/varieties their products, the system of protection of geographical indications (GI) has developed in the legal, policy, and socio-economic context in Vietnam. As of September 2018, there were 53 plant products with registered geographical indications in Vietnam, including fruits (25), rice (7), tea (3), coffee (2) and others (16) (Pick, Marie-Vivien & Kim 2017; Vietnam 2019).

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