COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE IN THAILAND (1997-2004)

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Written by

Wichar Thitiprasert, Chutima Ratanasatien, Songkran Chitrakon, Orapin Watanesk, Somsong Chotechuen, Veerana Sinsawat Forrer, Wilailak Sommut, Songpol Somsri, Prasartporn Samitaman and Suchitra Changtragoon

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Abbreviations and Acronyms

ABS	Access and benefit sharing
ACIAR	Australia Center for International Agricultural Research
AFTA	ASEAN Free Trade Area
ARDA	Agricultural Research Development Agency
ARCBC	ASEAN Regional Centre for Biodiversity Conservation
ASEAN	Association of South East Asian Nations
AVRDC	Asian Vegetable Research and Development Center
BIOTEC	The National Center for Genetic Engineering and Biotechnology
BOT	Bank of Thailand
BRDO	Biotechnology Research and Development Office
BRT	Biodiversity Research and Training Programme, Thailand
CBD	Convention on Biological Diversity
CFB	Community Forests Bill, Thailand
CGIAR	Consultative Group on International Agricultural Research
CHM	Clearing House Mechanism
CIFR	Center for International Forest Research
CIMMYT	International Maize and Wheat Improvement Center
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CODI	Community Organizations Development Institute
CPB	Cartagena Protocol on Biosafety
CRC	Community Rice Center
DIP	Department of Intellectual Property, Thailand
DNA	Deoxyribonucleic Acid
DOA	Department of Agriculture, Thailand
DOAE	Department of Agricultural Extension
DNP	Department of National Park, Wildlife and Plant Conservation
DPH	Department of Public Health, Thailand
EGAT	Electricity Generating Authority of Thailand
EEZ	Exclusive Economic Zone
EU	European Unions
FAO	Food and Agriculture Organization
FCRC	Field Crops Research Center
FCRI	Field Crops Research Institute
GATT	General Agreement on Tariff and Trade

GDP	Gross Domestic Product
GNP	Gross National Product
GEF	Global Environmental Fund
GIS	Geographical Information System
GMOs	Genetic Modified Organisms
GPA	Global Plan of Action
GPS	Global Positioning System
HRC	Horticultural Research Center
HRI	Horticultural Research Institute
HSRI	Health Systems Research Institute
IARC	International Agricultural Research Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFS	International Foundation for Sciences
IPGRI	International Plant Genetic Resources Institute
IPST	The Institute for the Promotion of Teaching Science and Technology
IRRI	International Rice Research Institute
ISSR	Inter-simple Sequence Repeat
ISTA	International Seed Testing Agency
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
ITTAM	Institute for Thai Traditional and Alternative Medicines
IUCN	International Union of Conservation for Nature and Natural Resources
MOAC	Ministry of Agriculture and Cooperative
MONRE	Ministry of Natural Resource and Environment
MTA	Material Transfer Agreement
MTEC	National Metal and Materials Technology Center
NBSAP	National Biodiversity Strategy and Action Plan
NECTEC	National Electronics and Computer Technology Center
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NFP	National Focal point
NGO	Non-Government Organization
NRCT	National Research Council of Thailand
NRM	National Resources Management
NSM	National Science Museum
NSTDA	National Science and Technology Development Agency
NTBC	Northeastern Thailand Biodiversity Center
ONEP	Office of National Resources and Environmental Policy and Planning

OTOP	One Tambon, One Product, Thailand
PCR	Polymerase Chain Reaction
PGD	Plant Genetic Diversity
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
PGRC	Plant Genetic Resources Center
PGRS	Plant Genetic Resources System
PIC	Prior Informed Consent
PVP	Plant Variety Protection
PVPD	Plant Variety Protection Division
QSBG	Queen Sirikit Botanic Garden
RAPD	Random Amplified Polymorphic DNA
RFD	Royal Forest Department, Thailand
RID	Royal Irrigation Department
RPV	Registered Plant Varieties
RRC	Rice Research Center
RRI	Rice Research Institute
SH	Stakeholder
TFR	Total Fertility Rate
TFT	Tropical Fruit Tree
TK	Traditional Knowledge
TRF	Thailand Research Fund
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNDP	The United Nations Development Programme
UNEP	The United Nations Environment Programme
UNEF	United National Environment Fund
UPOV	International Union for the Protection of New Varieties of Plants
US	The United States
WG	working group
WTO	World Trade Organization
WWF	Global Environmental Conservation Organization

Executive Summary

Introduction

The state of Thailand's Plant Genetic Resources for Food and Agriculture (PGRFA) Report for 1997-2004 is divided into 9 parts. Part I provides an introduction to the country and the agricultural sector. Part II provides an overview of the state of diversity. Part III provides the state of *in situ* management. Part IV highlights the state of *ex situ* management. Part V presents the state of use. Part VI provides the state of national programmes, training needs and legislation. Part VII presents the state of regional and international collaboration. Part VIII provides access to PGRFA, the sharing of benefits derived from their use, and farmers' rights. Part IX closes with a series of the most important issues on the contribution of PGRFA management to food security and sustainable development.

This report has been produced to provide an overview of the national activities on PGRFA. It is aimed at policy makers, funding agencies and research administrators but it is hoped that it will also be of use to the communities concerned. It results from the FAO/Government cooperative project, GCP\RAS\186\JPN, entitled "The Implementation of the Global Plan of Action (GPA) for the Conservation and Sustainable Utilization of PGRFA in Asia and the Pacific" with the objectives of promoting the implementation of the twenty priority activities of the GPA for conservation and sustainable utilization of PGRFA, and contributing to the establishment of a continuing monitoring framework for the GPA implementation at national and regional levels and a mechanism for gathering and sharing information, as well as for priority setting for GPA implementation.

An overview of the system

Agricultural production in Thailand has grown remarkably. One of the greatest periods of growth occurred between 1980 and 2000, when yields of rice, cassava, and sugarcane increased 40 percent, 30 percent, and nearly 25 percent, respectively. Approximately half of these increases in crop yields are attributable to genetic improvements, which have also led to varieties with better nutritional value and greater pest, disease, and stress resistance. The genes necessary for this crop improvement are contained in a broad array of plant materials, which when used in breeding or genetic researches are termed germplasm

Increased agricultural production has contributed significantly to Thailand's economy. Agricultural exports accounted for 3,868,358 million baht or 12 percent of total exports in 2004, the most recent year for which complete data are available. Crops and food products accounted for 80 percent of these exports. Plants also have significant economic value to pharmaceutical, fiber, chemical, and other industries.

Sustaining agricultural productivity will require continued use and access to a broad diversity of germplasm Managing Plant Genetic Diversity (PGD), therefore, is a strategic necessity for Thailand. Preservation of the tissues, seeds, and plants that comprise the nation's Plant Genetic

Resources (PGR) is the responsibility of various institutions, a diffuse network of laboratories and research stations.

Thailand PGR activities are supported at the national level by various institutions. The size and scope of many PGR collections and the volume of national and international distributions of samples from them are vague. Indeed, many PGR collections are considered to be valuable and important global resources. Efforts of scientists, technicians, and other support staff are needed.

As agricultural scientists and plant breeders improve crops, their need for germplasm will grow; the PGR System (PGRS) must keep pace. At the same time, concerns about the loss of PGR place an ever-greater significance on germplasm management and conservation and on a growing international role for the PGRS. By conserving the PGD of crop species and their wild relatives, the PGRS contributes to national and international efforts that address the loss of PGD.

To meet these increasing demands, it should have a centrally managed organization. At present, it exists within a decentralized framework in which a multitude of individuals, committees, and related institutions has varying levels of responsibility. This framework has hampered the ability of the PGRS to function as a coordinated, well-defined system with clear-cut leadership, responsibilities, and authority. It also constrains the resolution of long-standing needs and problems.

To meet both national and global needs, the PGRS must recognize and act on the needs of the nation's germplasm conservation. It must be guided by budgetary procedures that invest resources in areas of need and opportunity, and it must utilize evaluation and planning mechanisms that identify system wide needs and cost-effective solutions to recognized deficiencies. The basic conclusion is that it will remain very difficult, if not possible, for the system to function properly without a major overhaul in its structure and administrative procedures.

The national system's collections contain more than 120,000 different accessions of some 700 species, including virtually all of the crops of interest to Thailand agriculture. The collections are managed at various laboratories and facilities located throughout the country. Leadership and advisory functions within the national system are difficult to discern. The evolution of the system has produced numerous committees and individuals with varying degrees of authority and responsibility. As the lead agency for PGRS management, the Department of Agriculture (DOA) administers its programmes on food and agriculture through a decentralized system of area offices and its national programme staff.

Findings and recommendations

Although a number of activities have been carried out in the country to determine PGR in terms of economic, social, cultural, and ecological values, the efforts by PGR-related institutions have yet to successfully yield beneficial results since these institutions have not been sufficiently supported either financially or institutionally. At present, there are less than 30 taxonomists in Thailand even though taxonomic researches are an extremely crucial

element for better understanding of PGD. The research has not been fully carried out under the initiative of the institutions but rather by individual interests, which clearly indicates shamefully insufficient and unorganized support of genetic diversity research in Thailand. There is also lack of proper training programmes for local authorities assigned to protecting areas. Institutionally, plans and policies on the conservation of genetic diversity by plant genetic diversity–related institutions have never been, to any significant extent, integrated into the policies and plans for utilization of natural resources. For example, the planting of identical species in both reforestation and agricultural projects by governmental agencies has increased pressure on the diversity of natural PGR. Many other governmental agencies also consider the issue of genetic diversity as mere "theory" and continue to undertake development activities that wastefully destroy PGR, such as transportation, energy production, and irrigation projects, only to satisfy short-term economic return. Some other agencies, in response to accelerated economic development, even promote and support the harvesting of PGR with no regard to the long–term existence of such PGR. Therefore, strategies concerned with this aspect should be clear and made a national priority. Moreover, policy-making to support all needs should be taken in to account.

It will be seen that the number of institution with dedicated research programmes on PGRFA is very small. Much of the current activity is carried out through institutional arrangements. An analysis suggests that there is a need to re-think the current networks and a strategy for expanded research cooperation should include due attention to information sharing and to enhancing research priority setting and cooperative research.

The PGRS, as presently constituted, has no discernible structure and organization. It lacks a central, clearly defined authority and lacks processes for managing its activities, formulating national policies, identifying priorities, or developing budgets necessary to act on new policies and emerging priorities. Too many individuals, committees, and offices manage PGRS. Thailand can remedy these defects by creating a more centrally managed system It must take systematic actions in six critical areas: administration (especially in linking the budget process to key system needs), germplasm acquisition and collections, facilities and personnel, the mission of the national system, data management, and research.

The administrative and advisory organization of the PGRS should be structured to provide for efficient national coordination. The need to coordinate nationally a variety of activities and agencies and to respond to growing international relationships has made efficient management of the national system an imperative. The system's management structure must be made more compatible with its nature and activities. For example, the conservation, management, and distribution of germplasm are service activities.

At present, the PGRS is largely supported and managed by the DOA and the Department of National Parks, Wildlife and Plant Conservation (DNP). More direct authority and responsibility for budget and programmes of the PGRS must be vested in a centralized management unit to enable the system to respond more effectively to national needs and priorities. Effective national coordination of the PGRS depends on establishing a management structure that links programmes and policies to budgetary authority and budget process outcomes. The authority to formulate budget recommendations in accordance with the identified needs and responsibilities of Thailand PGR efforts must reside with an office or

individual intimately associated with the operation of the PGRS. This approach will also reduce the complexity of PGRS decision making and funding processes. Through a coordinated, national structure, the Thailand PGRS could also take the scientific and technical lead in guiding PGR activities in other nations and in the international community.

Options for achieving national coordination

From currently available information, the more acute needs in PGR conservation and utilization that may apply to most related institutions are summarized below.

- Lack of a nation-wide and comprehensive survey on existing PGR, the doubtful state of their security, and the urgent needs in operational capacity and human power are areas for assessment and remedies. It is highly desirable for the country to have a national Plant Genetic Resources Center (PGRC) that will coordinate and integrate activities of various agencies having PGR components.
- Lack of an effective and efficient information management system impairs periodic assessment of activities and effective control of genebank operations.
- Lower-than-desired level of international collaboration on germplasm forfeits the potential advantages of sharing information, the PGR, and technical expertise.
- *In situ* and on-farm conservation can supplement *ex situ* conservation efforts. Non-Government Organizations (NGOs), farm communities and schools will add to the forces of conservation.
- The underuse of conserved germplasm can be alleviated by renewed efforts in conventional and mission-oriented research, evaluation and breeding. Biotechnology should be used as a tool not a solution to all problems.
- Both biodiversity and PGD among major varieties of commercial crops should be restored to provide protection against long-range perils that upset stable ecosystems.
- Training of technical personnel is needed in all fields related to conservation and use.
- Collections must be managed. Elimination of administrative differences would promote cooperation among all the centers and would simplify the system's structure.
- Curators with specific knowledge should be appointed for each major crop or crop group, and they should be given management responsibilities. There is now no plan to ensure that knowledgeable, suitably trained curators oversee acquisition and management of the major or essential collections in the national system At present, some site managers oversee several crops. Curators must have specific knowledge about their crop plants and be familiar with their collection, documentation, regeneration, evaluation, and enhancement. They should work with the appropriate crop advisory committee and the leader of the PGRS to develop and implement plans for the management and enhancement of germplasm
- PGRS must involve more of its resources in regenerating seed accessions. Regeneration of seed lots with low germination is a continuing need. Regeneration of these samples is urgently needed. Where responsibility for providing fresh seed cannot be assigned

to an existing site, funds should be available to secure regeneration on a contract basis with appropriate supervision and safeguards.

- A plan should be developed for monitoring, supporting, and conserving important special PGR, both *in situ* and *ex situ*. Both *in situ* and *ex situ* conservation have proved invaluable.

- The management of large collections, such as those for rice, corn, and soybeans, could be aided by the identification of core collections.

- Funds should be made available for competitive, goal-directed research in areas of specific need.

- Building capacity and empowerment of local communities are the foundations for sustainable natural resource management.

- Address the problem of global loss of biological diversity. This can be done in significant part through conserving the PGD of crop species.

- The national seed storage laboratory for the PGRC must be improved and expanded.

- Facilities and programmes of the PGRS should undergo periodic external review.

- Sites should be established for the rejuvenation and maintenance of PGR that requires short-term and long-term conservation.

- The PGRC should develop clear, concise goals and policies that encompass the conservation of PGR that reflect the world's biological diversity and crop resources of immediate use to scientists and breeders.

- The PGRC must take an active role in developing national policies that guide relations with the Food and Agriculture Organization (FAO), international agricultural research centers, other international agencies, and national institutions.

- The PGRC should cooperate internationally with other related institutions to collect, conserve, regenerate and utilize PGR.

- The PGR Information Network must better reflect the collections, conservation, and sustainable utilization of PGR.

Introduction

Thailand and its Agricultural Sector

1. General background

Thailand is one of the South East Asian countries, and is located from 5-21 degrees North in latitude and from 97-106 degrees East in longitude. The country occupies a territory of about 514,000 square kilometers (51 million ha.). The climate is dominated by monsoons and is mostly hot and humid. Average annual rainfall is about 1,573 mm and average temperature ranges from 26-28 degrees Celcius.

Administratively Thailand is divided into four regions comprising of 76 provinces (Figure 1), each one headed by a governor. There are 787 districts and district branches, 7,404 sub-districts, and nearly 66,604 villages within the 76 provinces. Sixty four percent of the whole population resides in rural areas. Approximately 90 percent of the rural people, or 5.2 million farm families, earn their income through subsistence farming, particularly rice and other field crop cultivation.

Thailand is situated within two major biogeographically regions, the Indochinese region in the North and the Sundaic region in the South. Apart from the effect of these two regions within the Indomalayan Realm, some elements of Thailand's flora and fauna are also influenced by biogeographically characteristics of the Indian and Palearctic region. Thailand can be further divided into six biogeographically units, which include the restricted ranges of many local and endemic species as follows;

- The Northern Highlands is surrounded by mountain ridges and wide valleys that extend southward from the borders with Myanmar and Laos to about 18 degrees north. Prior to anthropogenic disturbance, a number of evergreen mountain forests were supported in the areas above 1,000 meters with mixed deciduous and dry dipterocarp forests on the lower slopes. The valley and upland areas have now been extensively cultivated especially by hill tribes, resulting in widespread deforestation.

- The Korat Plateau includes the Northeastern area of Thailand between the Petchabun range in the west and the Donglak range in the South along the Cambodian border. The plateau is now widely deforested with some tropical rain forests and dry evergreen forests persisting on the hills.

- The Central Plain of the Chao Phraya River is now almost entirely cultivated as paddy fields that has completely wiped out the previously existing freshwater swamps and monsoon forests.

- The Southeast Upland extends from the Cardamom Mountains in Cambodia. Semi–evergreen forests mostly cover the upland's area.

- The Tenasserim Hills extend southward along the border of Myanmar and rise steeply to about 1,000 meters above sea level. Even though the hills are situated in the rain shadow of the higher Myanmar side of the range, the hills have supported semi–evergreen forests on the

higher elevations. Previously existing deciduous forests on the sides of the hills are now heavily encroached or deforested and have been replaced with grasslands or bamboo forests.

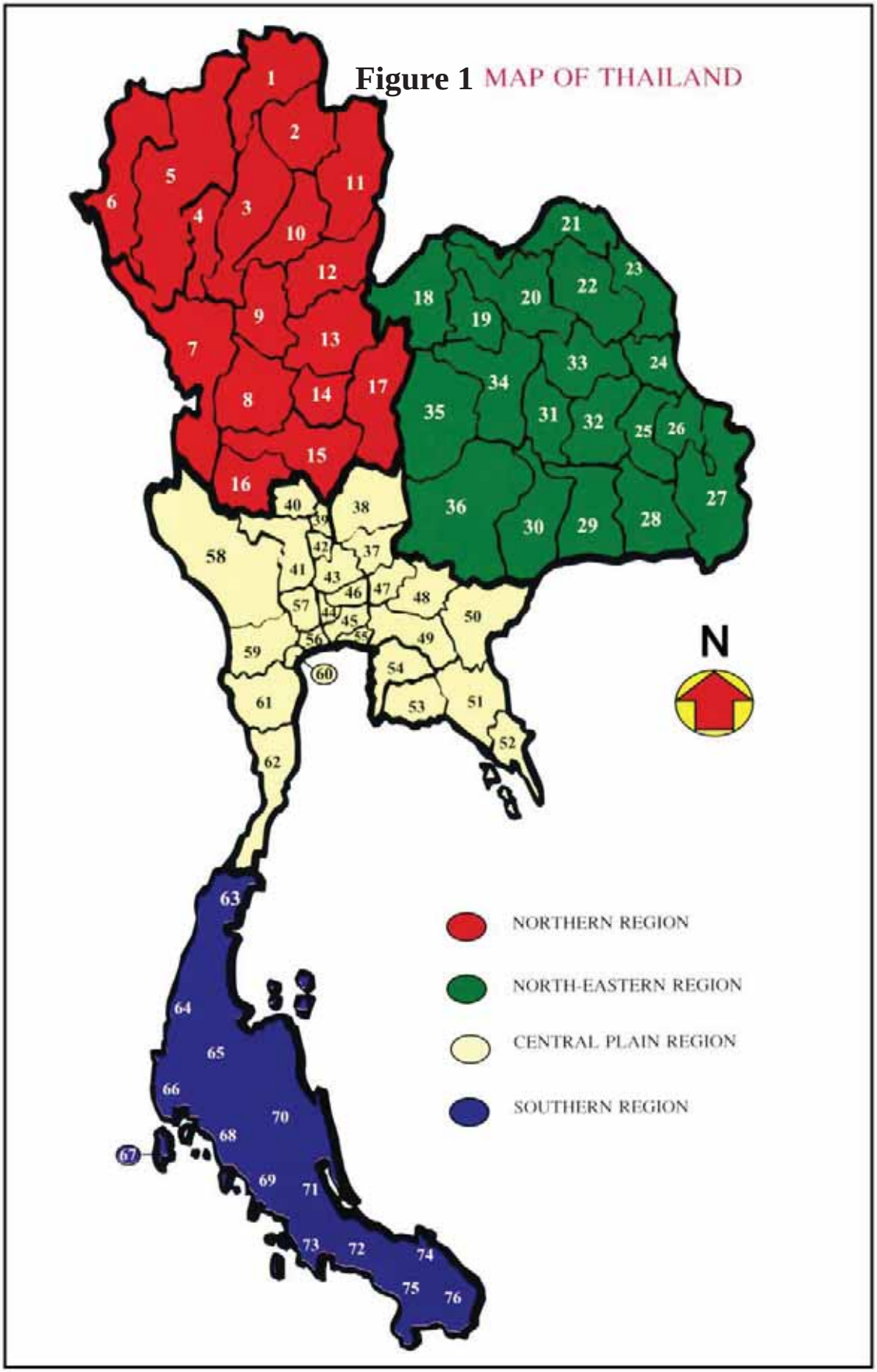
- The Southern Peninsula includes the area of Thailand south of the Kra isthmus to the Malaysian border. There is a distinct boundary at the Kra isthmus where a considerable number of Indochinese and Malaysian species of flora and fauna reach their southern and northern limits, respectively. High precipitation in the peninsula was able to support dense rain forests in the area. At present, however, most of these forests in the lowlands have been almost entirely cleared for agriculture and those forests on the hills are now threatened by ever–extending encroachment for rubber plantations and other cultivation.

These six biogeographically units have distinct floral and faunal associations. For example, many bird and mammal species of the Northern Highlands have Chinese affinities, which can not be found in other biogreographically units. Similarly, a number of mammal and bird species found in the Southern Peninsula have characteristics related to those of the Sundaic regions.

2. Population

The population of Thailand reached 63.36 million persons at the end of 2003, of which approximately 25 percent were under the age of 15. Thailand has made considerable progress with regard to its population policy through family planning programmes. The nation's Total Fertility Rate (TFR) declined from 2.66 % in 1981-1983 to 2.23% in the 1984-1987 periods. The population in Thailand by 2012 is predicted to be 68.19 million, or an increase of about 1 million a year.

Figure 1 MAP OF THAILAND



3. Agricultural resources

3.1 Land

Thailand occupies an area of 320.7 million (m) rai or 51 m ha (1 rai = 0.16 ha) and is considered an agricultural country. At least 18,000 plant species (8% of the world total) have been estimated to occur in Thailand. Of these, rice is the most diverse species. A wide range of rice genetic diversity has been found throughout the country. Approximately 130 m rai (41%) is engaged in agriculture. Of this agricultural land, about 49, 21, and 21 % is devoted to paddy rice, field crops and fruit trees, respectively. In the past land use for agriculture was tremendously increased through deforestation. Despite farmland expansion, crop productivity remained stagnant or even declines, whereas land quality has rapidly deteriorated. In addition, existing agricultural land has been partly changed to non-farm use in response to urbanization and expanding industrial zones. The land development policy, therefore, puts emphasis on accelerating land reform, land quality, land productivity and land conservation.

3.2 Water

Water Resources in Thailand are stored in two main sources: surface water and ground water. Water provides by rainfall, river basins, lakes, canals, swamps, irrigation water, and underground water. Among all, rainfall is the most important water source for agriculture with about 80% of agricultural areas being cultivated under rainfed conditions. Thailand receives rainfall with an average volume of some 752 billion cubic meters annually. The most important and the largest river basin in Thailand is the Chao Phraya Basin covering nearly all areas of the northern and central regions. Groundwater resources exist throughout the country but their quantity and quality vary according to local hydrogeological conditions. Several large-scale irrigation projects were constructed by the Royal Irrigation Department (RID) and the Electricity Generating Authority of Thailand (EGAT). At present, the most developed irrigation systems are found in the central plain. Nevertheless, due to economic growth and hence increasing demand for water resources, there remain important issues in relation to water resource development, that is, the maintenance of irrigation systems, and the efficient use, and optimal allocation of existing water.

4. Economic overview

In 1997, Thailand experienced the East Asian crisis, which combined the effects of both a currency crisis and an economic crisis. After depletion of its international reserves, the Bank of Thailand (BOT) had to float the currency on July 2, 1997, ending decades of a fixed exchange rate regime, and marking the beginning of the crisis. A number of major factors contributed to the 1997 financial crisis, including currency mismatches of the external debt, the failure of BOT in reviewing and adjusting policies, and the inefficiency and weakness of financial institutions, among others.

The Thai economy contracted by 1.4 percent in 1997 and 10.5 percent in 1998. Its recovery was gradual over the ensuing years. By the end of 2001, the level of real Gross Domestic Product (GDP) was still lower than that of 1996. Growth accounting shows that a drop in GDP during the period 1997-1998 primarily led to lower uses of capital stock (capital utilization

rates) and lower uses of labor inputs (unemployment). After the crisis period, the net capital stock started to expand gradually during the period of economic recovery. Nevertheless, the recovery period in 1999 and 2000 was shaky. Growth during the recovery period stagnated owing to the rising trend of unemployment. However, the Thai economy expanded substantially in 2002. The growth rate in 2002 was 5.4 percent compared with 2.1 percent in 2001; the year 2002 experienced the highest growth rate since the 1997 crisis.

The agriculture sector has played an important role in contributing to the growth of the economy since historical times. Agriculture has long been a major source of food supply and food security for Thai people and greatly contributes to farm workforce and industry employment as well as to the national income and foreign exchange earnings. As a result, the non-farm sector, namely industry, has been growing at a rapid rate during the past decade. Consequently, the contribution from agriculture has gradually declined in its importance to the share of economic growth. However, the value of the GDP from agriculture seemed to increase during the last 3 years (2002-2004). In spite of this, the share proportion seems to have remained the same (9-10%). Agriculture not only has a vital role in ensuring national food security but also contributes basic resources to the non-farm sector, particularly agro-industry. As a result, currently this industry sector contributes the most to GDP. The contribution of agricultural production to the overall national GDP fell from 39.2% in 1961 to 12.4% in 1995.

Currently, the total GDP values is 7,042,000 million baht. The main contribution comes from the industry sector (44%) followed by sales and services (15%) and the agriculture sector (10%). Thailand's economic growth has improved from -10.2 percent in 1998 to 6.3 percent in 2003. In addition, exports, private consumption, and private investment have all displayed encouraging signs. Despite global uncertainties due to the U.S.-Iraq war, terrorism, and SARS, Thailand has been able to withstand competently the knock-on effects from those events owing much to robust economic fundamentals embedded within the root of the Thai economy.

The growth rate of GDP at current value during the study period should reach the two-digit level. At these rates of GDP growth, national income will expand rapidly. Per capita (Gross National Product (GNP) is expected to increase from 48,557 baht in 1992 to 367,398 baht by 2012. The high growth of GNP will be directly related to the continued impressive export performance of the country. It is expected that the value of exports will increase by more than 10 times from 2000 levels. As a result, a trade surplus should probably be observed sometime in 2012.

Thailand's overall economic conditions remained at a satisfactory level, with strong support from high growth of exports and tourism, while private consumption and investment had slowed down. On the broader level, internal and external economic stability remained robust. On the external front, sustained growth of the world economy and stabilized oil prices has supported the Thai economy.

Historical, scientific, and social aspects have produced modern Thailand's unique approach to agriculture. Thailand is still an agricultural country as well as an important producer and exporter to the world due to its topographic and climatic conditions being suitable for farm

cultivation. Advanced technologies and new germplasm of crops, livestock and fisheries have been extensively applied which have tremendous yield and economic benefits.

The consequences of reaping benefits from agricultural development in the past, in which natural resources have been exploited dramatically for production and export purposes without paying attention to natural conservation, rehabilitation and restoration, has severely affected farmers' annual production returns. In addition, natural disasters, notably prolonged drought, volatility in agricultural commodity prices and the diminishing of financial funding sources have reduced farmers' incomes. These factors have forced farmers to engage in off-farm occupations.

Thus, present agricultural policies are focusing on farmers' welfare as the center of development. Other important policies are involved with increasing agricultural productivity, restructuring the agricultural sector, developing agricultural infrastructure, and the enforcement of strict regulations on natural resources. The country is attempting to expand agricultural product markets by speeding up multilateral trade agreements that aim to reduce and eliminate unfair trade barriers imposed by developed countries. The introduction of new bio-fuels as alternatives to petroleum has given alternative income earning opportunities for farmers.

5. Fishery resources

Fishery Resources in Thailand are occur in the Gulf of Thailand, the Andaman Sea, and in rivers, lakes, streams, canals, and reservoirs. The harvest includes fish, crustaceans, mollusks and other marine fauna and flora. Fishery resources can be divided into three groups: fresh water fishery resources, brackish water fishery resources, and marine fishery resources. During the past three decades the country's marine fisheries have been rapidly developed, contributing to an average output of some 2 million tons. This has placed Thailand in the top ten marine fishery product-producing countries worldwide. Nevertheless, the proclamation of Exclusive Economic Zones (EEZ) by neighboring countries in 1980 resulted in the loss of about 800,000 square kilometers of Thai fishing grounds as well as created frequent fishing conflicts. To resolve these problems, the Thai government has promoted joint-fishing ventures with other coastal states in recent years.

6. Forest

Forest resources in Thailand can be classified into five types: evergreen forest, mixed deciduous forest, dry dipterocarp forest, pine forest, and mangrove forest. Of these, the dominant type of evergreen forest is tropical rain forest covering 43% of total forest area. It is concentrated in the highest rainfall zone, i.e. in the southeast, the eastern coasts, and along the peninsula. Over the past three decades, Thailand's once abundant forests were excessively utilized through illegal logging, land encroachment and shifting agriculture. Based on statistical data from the DNP, the total forest area of the country in 2004 was 32.66%. About 80 percent of at least 10,000 forest tree and plant species in Thailand are medicinal plants.

Bhumiphamon and Kamkong (1997)[1] reported that about 242 multipurpose trees are edible and at least 300 plant species are sources of aroma. The edible plants have been surveyed currently in 25 national parks and wildlife sanctuaries. In 2004, Wongprasert reported that at least 701 of plants found, were edible species. Some of them are fruit trees such as *Garcinia* and *Mangifera* species. Many fruit tree species have been bred to improve taste and quality.

7. Farm size

The determination of farm size and its change over time is complex. Factors include history, institutions, economic development, the development of non-farm sectors (both in rural and urban areas), land and labor markets, and policies related to land tenure and property rights. Among these, land policy, institutions, and legislation have been the most influential factors.

The average farm size has remained on average constant over time at around 3.5 hectares in Thailand for the past several decades (Table 1).

Table 1 Average farm size in Thailand

Year	Farm size (hectare/household)
1999	3.71
2000	4.20
2001	4.00
2002	3.96
2003	3.91

8. Food production

The present interplay of the country's natural resources, application of technology, government policies, and the Thai people who engage in the agricultural sector has propelled Thailand's food production to a level that consistently exceeds annual domestic consumption. This should not be interpreted as meaning that Thailand can meet nutrient requirements and achieve firm food security. It merely reflects that Thailand produces food in excess of its population's ability or willingness to acquire and consume, directly or indirectly. The details of some major food products are as follows:

8.1 Crop components

There are 130 million rai devoted to the agricultural sector. The areas used for paddy, field crops, fruit trees, vegetables and flowers, housing and others are 64, 28, 28, 1.2, 3.6 and 5.2 m rai, respectively. Thailand has several major agricultural products which are also export products. These are rice, rubber, cassava, maize, coconut, tropical fruits, flowers, and vegetables. Major and minor commodities contributing to the nation’s economy are presented in Annexes 1and 2.

[1] Bhumiphamon and Kamkong 1997. Edible multipurpose tree species. Sub-Committee for Coordination on Research and Development of Forest Resources and Fast Growing Multipurpose Tree Species. Committee on Agriculture and Biology, National Research Council of Thailand. 485p.

8.2 Seed supply system

The private sector started with the importing and marketing of vegetable seed, principally by merchants in the main fresh vegetable market of Pak Klong Talad. The largest of these merchants developed specialized farms for testing imported cultivars. These developments took place from the 1920s to the early 1980s.

In the public sector, various research stations within the DOA released and distributed seed of improved cultivars of rice and field crops. The major government thrust in seed production started with the opening of the Pitsanulok Seed Center in 1974. In 1975, Kasetsart University released the Suwan 1 corn composite, and the first private field crop companies were set up under a Board of Investment promotion to produce and distribute maize seeds on a large scale. This led other private companies to follow in maize and expand to other field crops. By the early 1980s, the Department of Agricultural Extension (DOAE) had a number of seed centers, producing rice and field crop seed. They were particularly keen to:

- Produce good quality seed of some of the more difficult crops, for example, soybean and groundnut.
- Avoid competing with the private sector (for example, in maize).

Since the early 1980s the number of DOAE seed centers has expanded to the present 23, and the number of large private companies is now around 30 (2003). In addition, a large number of smaller private operators work in specific crops, or in seed accumulation and distribution in specific regions. More than 100 companies or individuals are registered as seed importers, exporters, or seed processors and marketers.

9. Livestock components

9.1 Cattle

Cattle are raised primarily for draught with meat production as a by-product. Most of farm families own a small herd, either of water buffalo or cattle, using low-cost production technology based on open access resources such as agricultural residues and farm labour. The major animal herding areas are in the northeast. In recent years, there have been increasing imports of live cattle for breeding. Cattle product imports have also increased in response to an expansion of the leather industry.

9.2 Dairy Cattle

Dairy cattle are mainly kept for milk production. The commercial production of dairy cattle in Thailand began after the establishment of a dairy farm and herd-training center funded by the Danish Government in 1962. Dairy production was then developed through the subsequent establishment of the Dairy Farming Promotion Organization of Thailand, a state-owned enterprise under the Ministry of Agriculture and Cooperatives (MOAC) in 1971. The present major dairy cow raising areas are Saraburi, Ratchaburi, Nakhon Pathom, and Chiang Mai. About 49% of milk production is processed for ready-to-drink fresh milk, and the rest for

reconstituted milk. Currently, milk production is insufficient to meet the rising demand generated by population growth and better standards of living. Dairy products, particularly in the form of milk powder, are thus imported. As for exports, Thailand exports only a small quantity of milk products to neighbouring countries such as Singapore, Laos, and Myanmar.

9.3 Swine

The largest swine production area is the Central Plain, accounting for about 36-40% of total production. This area consists of provinces around Bangkok such as, Nakhon Pathom, Ratchaburi and Chachoengsao. The Northern region ranks second, accounting for 20-30% of total production. Commercial production of swine in Thailand has developed slowly due to instability in the market price of pigs, feed costs and government regulations. Most production is consumed domestically through meat processing which consists of two types: (1) a variety of traditional meat products such as Chinese sausages, roasted pork, etc; and. (2) continental meat products such as ham, bacon, and baloney. A small number of live pigs and frozen piglets is exported to Hong Kong and Singapore.

9.4 Poultry

Poultry consists of broilers, hen-layers and duck-layers. Among these, the broiler industry has experienced a rapid expansion through the increase in the number of commercial farms during the past decade. The major zone of broiler production is in the Central Plain where more than 35% of all broilers is raised. The largest chicken-raising provinces are Chacheongsao, Nakhon Pathom, and Chon Buri. Chicken farms can be classified into two types: (1) independent commercial farms where growers employ modern farm management to grow their broilers and do their own marketing, and (2) contract farms of various types with price guarantee hire-to-grow (wage) contracts and open-account contracts. In addition to being domestically marketed, chicken meat in the forms of chicken parts and frozen meat is also exported to Japan, which accounts for the largest share of Thailand's market.

Native ducks have long been raised in Thailand for meat and egg consumption. The major duck raising areas are located in Chacheongsao, Chon Buri, Nakhon Pathom, Suphan Buri and Ratchaburi in the central plain region. Due to growing domestic demand, the Department of Livestock Development has introduced, in particular, breeds with high feed conversion ratios from abroad and encouraged commercial duck farms. Since then export market opportunities have opened to Thai frozen duck meat and eggs, although the value is considered relatively insignificant. The overseas markets include Hong Kong, Singapore, Japan and Germany.

9.5 Fishery and product components

a) Shrimp and Prawn

Shrimps and prawns are major export commodities contributing to a large amount of foreign exchange earnings annually. Shrimps and prawns are processed into chilled, frozen, dried, boiled, and canned products for export. Thailand's important markets for frozen shrimps and prawns are Japan, the United States, Singapore and France.

b) Squid

Squid, a marine product, ranks second to shrimps and prawns. Squid products processed into frozen and dried squid contribute to considerable export earnings. Major importers of Thai squid are Japan, Italy, France and Switzerland.

c) Fishmeal

Fishmeal, an essential source of protein, is processed mainly from trash fish. Most fishmeal production is consumed domestically. Domestic demand for high quality fishmeal has been rapidly increasing in response to the expansion of livestock and shrimp farming. Part of the high-grade fishmeal requirement can be met by imports.

d) Canned Tuna

Canned tuna accounts for the most important marine product export item contributing an export value of 10 billion baht each year. Production of canned tuna in Thailand has steadily expanded in response to increasing overseas demand. At present, there are 22 fish canning plants in Thailand. Canned tuna is exported to the United States, the United Kingdom, Germany and Canada.

10. Trends in crop production

Since 1970, increases in crop production have come from both the expansion of cultivated areas and improvements in yields. In response to high agricultural prices, the total area planted has continued to increase. Furthermore, farmers are switching from crops with relatively low returns per hectare to those with higher earnings. Performance, however, varies considerably; sugarcane, rubber and cassava yields have been increasing significantly, rice and maize yields growing slowly, and kenaf yield declining. The trend towards crop diversification continues in response to price incentives as the proportion of cropped area devoted to rice declines.

Although the national average rice yield has remained low, a recent trend clearly indicates certain structural changes in production. At present, rice cultivation is undertaken in intensive irrigated areas, wet-season irrigated areas, and rain fed areas. Intensive irrigated areas, which enable farmers to produce at least two crops a year, increased phenomenally from 407,488 hectares in 1977/78 to 4,240,000 hectares in 1992/93. Furthermore, there is ample evidence that yields in both intensive and wet-season irrigated areas have risen sharply during the past five years. About four million hectares of paddy land now benefit from wet-season flood control to keep fields free of excess water, which would damage crops. Nevertheless, the remaining six million hectares represent rice production in rain fed areas where limited access to modern technology and inputs results in low yields.

11. Trends in agricultural production

The trend of agricultural production in Thailand lies with the increase in the production of crops that can be exported. In the National Economic and Social Development Plan (NESDP)

number 9, a change from grain production to crops of high export potential or high value crops is expected to occur. In addition, the new picture of agricultural sector in Thailand includes more production in the agro-industrial area. The driving factors in changing the agricultural production system to the new structure of producing high value crops are due to the competition in value and quality of products in the international market. Increases in production costs especially in labor cost causes farmers to look for new crops of high value rather than being confined to their traditional crops.

Furthermore, it is envisaged that the structure of production in the agricultural sector as well as in farm households will change in line with the changing economic situation. Moreover, during the past few years problems such as water shortages for agriculture and low prices for rice prevailed. Therefore, the government's policy has emphasized restructuring the agriculture production system in line with the availability of natural resources, the market demand and the readiness of farmers by a) introducing other promising crops as substitutes for the second rice crop and b) replacing rice with more remunerative commodities in areas unsuitable for rice cultivation.

In the future, it is expected that agricultural production in Thailand will change from traditional production to the use of new technology for the production of high value crops. The trend for consistent increases in production may be seen in rice and crops that produce raw materials in agro-industrial manufacture such as oil crops, cassava products, maize, and sugarcane. Those that may rapidly increases in both production and export are fruits and vegetables, shrimp and sea food products, frozen chicken and other meat products.

In addition to the physical and climatic problems associated with different crop ecosystems, the main problems that farmers face are stagnating yields and labor shortages. The greater constraint is the shortage of labor during peak periods, especially in the central region where industrial employment is higher than in the other rice-producing regions. Mechanization of agricultural operations is almost complete and combine harvesters are widely used.

12. Process of preparing the country report

The representatives of core institutions indicated in Annex 3 were formed as a Working Group (WG) and assigned to prepare each part of the report as follows:

12.1 The executive summary and introduction: Plant Varieties Protection Division (PVPD).

12.2 Chapter 1, the state of diversity: Dr. Songkran Chitrakon, project consultant, DNP and DOA.

12.3 Chapter 2, the State of *In situ* Management: DNP and Chiang Mai University.

12.4 Chapter 3, the State of *Ex situ* Management: Biotechnology Research and Development Office (BRDO), and Rice Research Institute (RRI).

12.5 Chapter 4, the State of Use: Field Crops Research Institute (FCRI), and Horticultural Research Institute (HRI).

12.6 Chapter 5-7, the State of National Programmes, Training needs and Legislation, the State of Regional and International Collaboration, and Access to PGRFA: PVPD.

12.7 Chapter 8, the Contribution of PGRFA Management to Food Security and Sustainable Development: PVPD and RRI.

Moreover, there were three meetings of the WG, in March 2006, April 2006, and June 2006. All assignments from each institution have been reviewed, edited for consistency and prepared in the format as recommended in the document, CGRFA-10/04/Inf.8.

Chapter 1

The State of Diversity

1. The main values of PGR

The country's most important crops are rice, maize, soybean, cassava, sugarcane, oil palm, coconut, durian, mangosteen, pineapple, and rubber (Table 2). Among them, production of each region is different. Thailand is the world's biggest rice exporter. Total rice production amounted to 28.5 million tons in 2004. Agricultural products in 2004, accounted for 11.7% of exports and Thailand's agricultural trade surplus was nearly $4.5 billion (10th in the world). Apart from rice, the others also play an important role in term of food security and socio-economics with production rates varying directly with the area of production.

Table 2 **The most important crops in Thailand**

Crop	Growing season
Rice	Year round/seasonal
Maize	Year round/seasonal
Soybean	Year round/seasonal
Cassava	Year round/seasonal
Sugarcane	Year round/seasonal
Pineapple	Year round/seasonal
Durian	Year round
Mangosteen	Year round
Rubber	Year round
Oil palm	Year round
Coconut	Year round

2. Diversity within and between crops

2.1 Major and minor crop

The diversity of major crops as well as planted area, production, and value of both major and minor crops has changed slightly over the last 10 years (Annex 1, 2). The genetic diversity of local rice has been critically decreasing. In the past, each family grew 3-5 rice varieties in their rice fields. Presently, due to government extension and promotion programme, farmers have gradually changed from local varieties to recommended varieties such as RD6, RD8, RD15, Khao Dawk Mali 105, Chai Nat 1, Pathum Thani 1 and Suphan Buri 1, etc.

In 1999, the government's official policy was to encourage farmers to grow and even expand the planted areas of sunflower, baby corn, banana, and longan for export. We can see that increased production is the result of an increase in planted area. Yields have been rather static. For upland crops, Thailand's variable rainfall (and consequent risks) has discouraged farmers from using higher levels of technology such as more fertilizer. However, domestic demand for produce and competition for land resources are increasing. These factors are pushing farmers to improve yields through more efficient technology. This will increase demand for better seed and planting materials. Moreover, DOA has used the Geographical Information System (GIS) to predict the location of major crop populations from agro-climatic data and has used molecular markers to gauge some of the genetic diversity of these populations. This information can be used for selecting areas for *in situ* conservation and for planning future collecting missions.

2.2 Wild plants for food production

Some institutions are increasing their efforts to study and promote the conservation of genetic resources of wild crop relatives and wild plants. In Thailand, wild plants have been used as traditional food, as medicine and as functional foods.

A number of programmes have been initiated to survey and inventory wild plants for food production. For example, DOA has carried out some projects that survey wild rice, wild *Vigna*, wild sugarcane**,** mulberry, litchi, mango, wild relatives of tropical fruits and scented wood.

Furthermore, DOA plans to develop methods to survey and assess intra- and inter-species diversity in agro-ecological systems and wild species populations of rice. However, strategies and methods for locating and measuring PGD, and for estimating and monitoring genetic erosion have not been a priority of Thailand.

Based on an edible plants survey in 25 national parks and wildlife sanctuaries in Thailand, the numbers of edible plant species in different locations was determined as shown in Table 3 (Wongprasert, personal communication). In addition to this surveys, Wongprasert (2005)[2] has surveyed and identified 97 edible wild plant species in limestone areas as shown in Annex 4a. Some wild fruit tree species are related to economic fruit tree species in Thailand, namely *Mangifera* spp., *Garcinia* spp. and *Nephelium* spp. Smithinand (2001)[3] reported the existence of 18 species of *Mangifera*, 25 species of *Garcinia* and 7 species of *Nephelium* in Thailand. The species and their distributions are summarized in Annex 4b. Because information on the genetic resources of these species is lacking, therefore, survey and study of their genetic structure is urgently required.

[2] Wongprasert, T. 2005. Edible plants on limestone areas in Thailand. Pp. 176-181. *In:* The Proceedings of Biodiversity of Forest and Wildlife Seminar: Research and Activities in 2005. Regent Cha-am Hotel, Petchaburi, Thailand, 21-24 August 2005.

[3] Smithinand, T. 2001 Thai Plant Names. The Forest Herbarium, Royal Forest Department. (Revised Edition). 810 p.

Table 3 **Types and locations of edible plants found in 25 National Parks and Wildlife Sanctuaries in Thailand**

Types and locations	Number of edible plant species
General local edible plants	169
Limestone mountains	97
Northeast	76
West and South	112
Southeast	85
Central	45
North	117
Total	701

Over the past few years, a number of projects have been undertaken concerned with PGRFA survey and inventory PGR (Box 1). Survey and inventory provides a way of conserving traditional crop cultivars *in situ* and is regarded as having a number of advantages over *ex situ* conservation. It is dynamic, maintaining the adaptive capacity of the material and allowing it to evolve and change to meet users' needs or changing environmental conditions. It ensures that users are directly involved in conservation and continue to have access to the material. It is generally thought that maintaining a range of traditional cultivars provides resources for poor farmers with a risk-avoidance strategy, optimizes the use of different types of land and labor, and provides materials with a range of different uses for varied situations.

Most of the survey and inventory projects that have been undertaken are small-scale experimental actions, involving a few communities or villages in only a few locations in the country. The effects of these actions on availability of diversity at multiple levels are difficult to determine. However, the projects seem to increase local knowledge and awareness of the diversity available within an area, and they provide a good framework for increasing the likelihood that such materials will be maintained. Information on specific useful traits possessed by individual cultivars is made available, and is useful for future *in situ*, *ex situ*, and on farm conservation frameworks.

Although there have been a number of surveys and inventories conducted, most have not been carried out under initiatives of institutions but rather according to individual interests. They are not the national priority. However, DOA has prioritized some areas where *in situ* activities already exist and where there is potential for *in situ* collection of PGR in the future (Annex 5).

Box 1 PGRFA Survey and Inventory Activities

- Biodiversity and molecular aspect of *Curcuma* species from the northeast of Thailand.
- Evaluation of the status of genetic resources of mangrove tree species (*Rhizophora mucronata*) by using molecular markers
- Evaluation of the genetic resources of *Tectona grandis* (Linn.) using molecular markers
- Evaluation of the status of genetic resources and mating systems of forest trees and plants in forest conservation areas by molecular markers for sustainable conservation and utilization
- Flora of Thailand Project
- Measuring gene diversity of forest tree species in Thailand by means of isoenzyme gene and deoxyribonucleic acid (DNA) markers
- Survey and selection of indigenous rice varieties
- Survey and vegetative propagation of rare endangered plant species and economic forest trees by means of biotechnology
- Integration of biodiversity management of forest and wildlife for conservation and sustainable utilization
- Integration of biodiversity management of forest and wildlife for conservation and sustainable utilization
- Survey of bamboo species for the establishment of species and clone bank and genetic variation study
- To survey, collect, characterize, evaluate and manage the database and documentation on soybean germplasm

2.3 Forest Diversity

The majority of plant species in the country are closely related to species in neighboring countries. Thus, Thailand could be considered as a collective center of botanical species from 3 major regional elements: an Indo–Burmese element, an Indo–Chinese element and a Malaysian element. Approximately 2,819 species of Thailand's plants have been recorded in botanical references (Flora of Thailand) and account for an estimated 23% of total vascular plant species in Thailand.

It is estimated that there are approximately 12,000 vascular plant species in Thailand including 658 species of Pterophyte and over 1,000 species of orchids. More than 1,000 species of vascular plants possess active herbal ingredients used for traditional medicines, not including over 3,000 species of mushroom and fungi. At present, the forest herbarium at DNP has collected approximately 200,000 plant specimens and approximately 255 specimens are "type specimens". All collected specimens account for over 80% of vascular plants in the country. It is expected that, with continuous site–specific sample collections and surveys, more new species can be found. For example, surveys of plant species in a 50,000-rai area of Pru To Dang peat swamp forest, Narathiwas province, have resulted in the finding of 316 species of

vascular plant from 101 families in which 48 species were found to be new records for Thailand. The continuous discovery of new plant species has also been demonstrated by the finding of 1,100 species of flowering plant in Doi Suthep–Pui National Park which is up from 679 species found in a survey in 1964 (Sawyer and Chermsirivathana, 1969)[4]. At present, continuous researches have now found up to 2,247 species of vascular plants (Maxwell and Elliott, 2001)[5]. It is estimated by Forest Herbarium of DNP in 2003 that approximately 80% of 1,000 well known plant species, such as fruits, flowers and vegetables, is introduced (the remaining 20% is indigenous). This clearly shows the lack of knowledge of plant resources among Thai researchers which, sometimes, results in the introduction of ecologically harmful weed species such as *Mimosa pigra, Eichhornia crassipes, Eupatoriam odoratum*, *Pennisetum polystachyon,* etc. Excluding Thallophytes and Bryophytes, Thailand's plant species comprise approximately 303 families, 1,363 genera and 10,234 species (Forest Herbarium, 2003) which can be categorised as follows:

- Ferns comprising 658 species from 132 genera in 34 families. These species have been completely revised.
- Gymnosperms comprising of 25 species from seven genera in six families. These species have been completely revised.
- Angiosperms comprising of approximately 9,551 species from 1,224 genera in 263 families. Of these 2,136 species from 705 genera in 109 families have been completely revised.

As mentioned earlier, Thailand does not have significant unique floristic elements of its own, which results in a relatively low number of endemic species. In 2002, the Flora of Thailand project reported 248 species from 94 genera in 43 families that were endemic plant species. They included 24 species (from 22 genera in 13 families) of ferns (Annex 6), 224 species (from 72 genera in 30 families) of angiosperm, which can be divided into 25 species (from 8 genera in 6 families) of monocotyledons (Annex 7), and 199 species (from 64 genera in 24 families) of dicotyledons (Annex 8).

About 80 percent of at least 10,000 forest tree and plant species in Thailand are medicinal plants. In 1997, it was reported that about 242 multipurpose trees were edible and at least 300 plant species were sources of aroma. Edible plants were surveyed in 20 national parks and wildlife sanctuaries in 2005 and at least 701 plants found, were edible species. Some of them were fruit trees such as *Garcinia* and *Mangifera* species. Many fruit tree species have been bred to improve taste and quality. They are often cultivated, consumed and commercialized widely in Thailand. However their wild ancestors and relatives are less known, since they are distributed naturally in forests and protected areas. Most of them are not as tasty as the improved species or varieties. In practice, edible wild plants and fruit tree species are conserved in protected areas or community forests. Local people also exploit some edible wild

[4] Sawyer, J.O. and C. Chermsiriwathana. 1969. A Flora of Doi Suthep-Doi Pui,. Chiang Mai, Northern Thailand" Nat. Hist. Bull. 23: 99-132

[5] Maxwell, J.F. and S. Elliott. 2001. Vegetation and Vascular Flora of Doi Sutep-Pui National Park, Chiang Mai Province, Thailand. Thai Studies in Biodiversity 5. Biodiversity Research and Training Programme, Bangkok.205p.

plant species. Some forest communities play a major role on the best practice for conservation management of edible wild plants. However, so far only the natural distributions of these edible wild plants are known, and the status of their genetic resources is not clear. Therefore, assessment of the diversity and genetic resources status of edible wild plant species should be carried out in the future. Furthermore, the genetic diversity and mating system in some economically important forest tree and wild plant species in Thailand such as indigenous pines (*Pinus merkusii* and *P. kesiya*), neem (*Azadirachta indica* var. siamensis, *A. indica* and *A. excelsa*), *Dipterocarpus alatus*, teak (*Tectona grandis*), rattans (*Calamus* spp.), paper bark tree (*Melaleuca cajuputi*), *Mitragyna brunonis*, *Pterocarpus macrocarpus*, Mangrove tree speicies (*Rhizophora apiculata* and *R. mucronata*), *Cycad siamensis*, bamboo (*Bamboosa bambos*), Lady slipper (*Paphiopedilum exul*) have been evaluated by using isoenzyme gene and DNA markers and financially supported by RFD, DNP, Biodiveristy Research and Training Program(BRT), International Foundation for Sciences(IFS),Australian Center for International Agricultural Reasearch (ACIAR), International Plant Genetic Resources Institute (IPGRI) or Biodiversity International, Volkswagen Stiftung and Center for International Forestry Research (CIFR). Some of those results are summarized in Table 4.

Table 4 **Genetic diversity and mating system of some investigated forest and wild plants species**

Species	Molecular genetic variation		Gene diversity	Genetic differentiation among population Fst,,Theta P	Out crossing rate (tm)	References
	Isoenzyme gene markers	DNA markers				
Bamboosa bambos		SSR	0.369	0.2432		Ladpom and Changtragoon, 2005[6]
Paphiopedilum exul		AFLP	0.3013	0.0821		Wanichkul, and Changtragoon,2005[7]
Pinus merkusii	/		0.058	0.104	0.017-0.843	Changtragoon and Finkeldey, 1995[8]
Tectona grandis	/	RAPD	0.310	0.217	0.872-0.995	Changtragoon and Szmidt, 2000[9]
Rhizophora apiculata		AFLP	0.316	0.250	0.241-0.978	Changtragoon, 2005[10]
Rhizophora mucronata		AFLP	0.385	0.212		Changtragoon, 2005[10]

[6] Laphom,R. and S. Changtragoon. 2005. Evaluation of genetic diversity of some bamboos in Thailand using AFLP(Amplified Fragment Length Polymorphism) and microsatellite markers.Pp. 352-370. *In:*The Proceedings of Biodiversity of Forest and Wildlife Seminar: Research and Activities in 2005. Regent Cha-am Hotel, Petchaburi, Thailand, 21-24 August 2005

[7] Wanichkul,j. and S. Changtragoon. 2005 Investigation of genetic diversity of *Paphiopedilum exul* by AFLP (Amplified Fragment Length Polymorphism) markers. Pp. 342-367. *In:*The Proceedings of Biodiversity of Forest and Wildlife Seminar: Research and Activities in 2005. Regent Cha-am Hotel, Petchaburi, Thailand, 21-24 August 2005.

[8] Changtragoon,S. and R. Finkeldey. 1995. Patterns of genetic variation and characterization of the mating system of *Pinus merkusii* in Thailand. Forest Genetics 2(2) : 87-97.

[9] Changtragoon,S. and A.E. Szmidt.2000.Genetic diversity of teak(*Tectona grandis* Linn.F.) in Thailand revealed by Random Amplified Polymorphic DNA (RAPD).Pp.82-83. *In:* IUFRO Working Party 2.08.01 Tropical Species Breeding and Genetic Resources: Forest Genetics for the Next Millennium International Conference Centre, Durban, South Africa. 8-13 October 2000.

[10] Changtragoon, S.2005 The molecular genetic approach to forest genetic conservation and plantation management. *In:* International Seminar on Plantation Forest Research and Development, 21-22 November 2005, Yogyakata, Indonesia. 26p.

For example in the case of teak, fifty-one RAPD loci were identified and used to evaluate the genetic diversity in fifteen natural populations of teak in Thailand. Partitioning of genetic variation into within and among population components revealed that about 21 % of the total variation was attributable to differences among populations. The number of polymorphic loci in most of the investigated populations was very high with an average of 72.6%. The average expected heterozygosity was 0.310. Significant differences in allelic frequencies were found for most pair wise comparisons between populations. The out crossing rate ranged from 82-97%. These results suggest that natural populations of *Tectona grandis* in Thailand are highly differentiated genetically, implying that multiple sources of materials from at least one population of each province in the northern and central parts of Thailand may be required for both *in situ* and *ex situ* gene conservation.

For the mangrove forest tree case, *Rhizophora mucronata* populations in natural distribution at the gulf of Thailand and east and west coast of the South of Thailand were surveyed. The leaf samples from 15-40 individual trees per population have been collected in 16 populations. Out of 188 AFLP loci, 56 polymorphic loci were used to investigate genetic diversity of all investigated populations. The results showed that the proportion of polymorphic loci was greater than 50% in most populations with the range from 57% to 100%. Similarly, the measures of gene diversity were relatively high with the range from 0.243 to 0.448. Partitioning of genetic variation into within and among population components, revealed that as much as 21% (Thetha P = 0.212) of the total variation was attributed to differences among populations. According to UPGMA dendrogram two groups of populations could be distinguished: One comprising populations from the gulf along with the east cost of Thailand and the other comprising populations from the west (Andaman) coast of Thailand. However, the genetic structure and variation of some populations did not reflect the geographic distribution which may be caused by the mixing of genetic resources during reforestation in the pas. Results of this study suggest that the genetic diversity of *R. mucronata* in Thailand is rather high and AFLP's marker may be used to identify the origin of the genetic resources or provenances between the gulf & east coast and west (Andaman) coast of Thailand. The application of this study and further study in genetic diversity would be a useful tool for formulating criteria for the management of gene conservation and proper reforestation of this species in Thailand .

Based on such results, among the populations examined those genetically most diverse within and among populations of the species should merit a high priority for conservation. Since forest trees are long lived compared to annual or crop plants, high genetic diversity and out crossing rate would result in a higher possibility for their survival, viability, longevity, and disease and insect resistance for the present and forthcoming generations in a changing environment. A combination of marker-aided population genetic analysis and information about adaptive and quantitative traits as well as forest ecosystems would allow for the development of a comprehensive conservation programme for individual species in each forest type.

2.4 Threats of genetic vulnerability

Thailand promotes and facilitates the use of greater diversity in breeding programmes and in the varieties and species grown on-farm, to reduce the vulnerability and increase the stability

of agricultural systems. In this regard, the Plant Varieties Protection (PVP) Act was enacted in B.E. 2542 (1999) to promote the use of local and wild plant varieties by breeders and farmers in their breeding and farming programmes for new varieties of plants. As a result, a breeder as the rights holder of a new plant variety shall have the exclusive rights to produce, sell or distribute in any manner for import or export or possess the propagating materials of a new plant variety. Furthermore, farmers shall have the rights to keep such materials for their own planting. DOA, for example, is emphasizing the delivery of improved rice and fruit crop populations targeted to different agro-ecological conditions all over the country. Some institutions are expanding the range of crops they are working with, although financial constraints present a barrier.

In Thailand, at least 1,424 plant species are threatened and endangered, of which 757 are endemic species. One of them, *Alnus thaiensis* (Betulaceae) is already extinct. A fossil was found at Li district, Lampang province. *Amherstia nobilis* is extinct in the wild but is bred for commercial and conservation purposes; it was originally found in the border area of Mae Hong Son province and Myanmar. Two species are extinct in the wild including *Vanda coerulescens* (Orchidaceae) originally found at an altitude of over 1,000 meters in Chiang Mai, Mae Hong Son and Phrae provinces, and *Amherstia nobilis* (Leguminosae–Caesalpinioideae) originally found in dry evergreen forest in Mae Hong Son province.

At least 20 species are critically endangered, two of which are *Cycas chamaoensis* found at Chamao Mountain, Chanthaburi province and *C. tansachana* found in Saraburi province. The others are 18 species in the Dipterocarpaceae family, which includes two species of *Anisoptera*, two species of *Dipterocarpus*, five species of *Hopea*, and 7 species of *Shorea*.

There are at least 134 endangered species of which 94 are wild forest plants, such as 9 species of *Bulbophyllum* spp., 11 species of *Dendrobium* spp. and 15 species of *Paphiopedilum* spp., which have been collected for commercial purposes. Their habitats are facing destruction. In addition, there is *Bretschneidera sinensis* (Bretschneideraceae) which is found in Doi Phuka Mountain in Nan province and in northern Vietnam and southern China. There are at least 440 vulnerable species. Some examples are *Wrightia sirikitiae* (Apocynaceae) found in limestone mountains in Nakhon Sawan, Saraburi and Srakaew provinces, *Pedicularis nigra* (Scrophulariaceae) found in Chiang Mai and Mae Hong Son provinces at an altitude of more than 1,000 to 1,500 meters above sea level, and in Yunnan province in China, *Isachne smitinandiana* (Gramineae) found only at Phu Kradueng and Phu Luang Mountains in Loei Province, *Caulokaempferia thailandica* (Zingiberaceae) and *Agapetes saxicola* (Ericaceae). Table 5 shows the number of threatened species identified by the Bangkok Forest Herbarium DNP in 2005. A number of local orchid species such as *Paphiopedilum niveum*, *Paphiopedilum sukhakuluii*, *Rhynchostylis coelestis*, *Rhynchostylis gigantea*, *Vanda coerulea*, *Vanda denisoniana*, *Dendrobium scabrilingue*, *Dendrobium tortile* etc. are now endangered. *Vatica diospyroides*, which is a large tree species with pleasant smelling flowers, is now regarded as a rare species. In addition, at least 133 endemic and rare plant species were reported by Santisuk (2005)[11]. Also, Pooma *et al.* (2005)[12] has compiled a preliminary check-

[11] Santisuk,T. 2005. Endemic and rare plant species in Thailand. National Park, Wildlife and Plant Conservation Department. 179 p.

[12] Pooma,R., S. Suddee, V. Chamchumroon, N. Koonkhunthod,K.Phattarahirankanok,S. Sirimongkol and M

list of threatened plants in Thailand as a first round investigation of potentially threatened vascular native plants in Thailand. Endemic and rare taxa are included with notes on their habitats and distribution ranges. This inventory covers 1,131 taxa within 394 genera and 48 families; of which 16 species are new to Thailand, 4 species are most likely to be new to science. It is hoped that this checklist will serve as a basis for a thorough assessment of all vascular plants in Thailand by using International Union of Conservation for Nature and Natural Resources (IUCN) categories and criteria of threats.

Table 5 **Threatened plant species**

Plant groups	Threatened species	Endemic species	Total no. found in Thailand
Pteridophyte	41	19	468
Gymnospermae	27	0	32
Angiospermae	1,356	738	8,560
Monocotyledonae	416	211	2,756
Orchidaceae*	175	87	1,200
Palmae*	85	16	150
Zingiberaceae*	57	27	270
Dicotyledonae	940	527	5,804
Euphorbiaceae*	79	47	425
Rubiaceae*	71	53	600
Gesneriaceae*	63	46	144

Note: *Only major families are listed.

2.5 Modern varieties

Over the past 10 years, trends have shown an overall increase in using modern varieties to enhance the quantity of high quality seed to supply farmer demand. A number of activities have been used to broaden efforts to promote the availability of good quality seed in a wide range of crop varieties as shown in Table 6.

Poopath. 2005. A Preliminary Check-list of Threatened Plants in Thailand. National Park, Wildlife and Plant Conservation. Bangkok, Thailand. 193p.

Table 6 Crops promoted for breeding programmes

Name of crop	Reference	Incentive target
Rice	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production
Sugarcane	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production
Mango	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing
Dendrobium sp.	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Vettiver grass	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production
Crown of thorn	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Crested euphorbia	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Tomato	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Chili	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Cucumber	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Water melon	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Bitter gourd	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Water convolvulus	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Chinese kale	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Chinese white cabbage	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Corn	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Soybean	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Mungbean	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Yard long bean	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Pummelo	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Durian	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Litchi	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Longan	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing

Table 6 Crops promoted for breeding programmes (Cont.)

Name of crop	Reference	Incentive target
Cassava	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Curcuma	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Rambutan	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Annona	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Orange	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Common lime	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing
Lotus	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Water lily	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Giant water lily	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Vanda	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop marketing
Tamarind	Plant Varieties Protection Act B.E. 2542 (1999)	Crop production; Crop processing; Crop marketing

Moreover, a number of crops indicated in Table 7 have had varieties registered as Registered Plant Varieties (RPV) according to the Plant Varieties Act 1975 for the purpose of their quality and recommended varieties. In this regard, hundreds of crop varieties have been released so far. The quality of such seed is based on International Seed Testing Agency (ISTA) rules and based on nationally defined standards. Major crops or cropping systems and percentage area sown to modern varieties are shown in Table 8.

Table 7 Crops with registered plant varieties

Name of crop	Type	Origin
Rice	Improved variety	National
Rice	Local variety	National
Barley	Improved variety	National
Wheat	Improved variety	National
Maize	Improved variety	National
Sweet corn	Improved variety	National
Sorghum	Improved variety	National
Mungbean	Improved variety	National

Table 7 Crops with registered plant varieties (Cont.)

Name of crop	Type	Origin
Black gram	Improved variety	National
Groundnut	Local variety	National
Groundnut	Improved variety	National
Bambara groundnut	Improved variety	National
Soybean	Improved variety	National
Black soybean	Improved variety	National
Soybean	Improved variety	National
Sesame	Improved variety	National
Castor	Improved variety	National
Sugarcane	Improved variety	National
Mulberry	Improved variety	National
Mulberry	Local variety	National
Cocoa	Improved variety	National
Oil palm	Improved variety	National
Cashew nut	Improved variety	National
Kenaf	Improved variety	National
Roselle	Improved variety	National
Jute	Improved variety	National

Table 8 Major crops or cropping systems and percentage area sown to modern varieties

Name of crop	Estimated percentage of area sown to modern varieties	Source of estimate
Rice	85	Expert DOA [estimate]
Maize	95	Expert DOA
Vegetable	95	Expert DOA
Ornamental plants	95	Expert DOA
Sugarcane	99	Expert DOA
Sesame	5	Expert DOA
Tropical fruits	5	Expert DOA
Cassava	100	Expert DOA
Soybean	100	Expert DOA
Mungbean	100	Expert DOA
Para rubber	100	Expert DOA
Oil Palm	100	Expert DOA
Pineapple	95	Expert DOA

2.6 Landraces

Data on landrace populations are rare because questions concerning genetic erosion arose after these populations had been affected by technological change. Agricultural data, for instance, on the extent of modern varieties in Thailand was virtually non-existent in the last decade, and remains spotty and unreliable. A better taxonomy of cultivated plants based on a species concept is crucial. Frequent variety turnover was an important part of traditional rice agriculture in Thailand. Indigenous rice varieties are regularly acquired from distant locations. Farmers sow 1.7 varieties per farm and replace them on average every three years. During the last 4 decades, the use of rice diversity has been decreasing and this is driven by demand.

3. Factors influencing the state of PGD

3.1 Incomes

Over the past 10 years, farmers have switched from growing crops with relatively low returns per ha to those with higher earnings. Performance, however, varies considerably: sugarcane, rubber and cassava yields have been increasing significantly, rice and maize yields growing slowly, and kenaf yield declining. The trend towards crop diversification continues in response to price incentives as the proportion of cropped area devoted to rice declines.

Farmers no longer want to grow diverse sets of varieties, particularly landraces. As they become integrated into the market and have greater opportunities to access modern varieties, sell surpluses, and purchase products, farmers prefer specialization and plant a few high-yielding modern varieties that provide them with higher incomes. Increasingly, small-scale farmers and their households participate in labor markets. In fact, this is the most important link to the market, particularly compared with selling agricultural products. For most farmers, agriculture is one among many income-generating activities that include off-farm labor and temporary migration. Expanded participation in labor markets increases the opportunity cost of time for farmers and their families. To maintain crop diversity on their farms, farmers have to invest in labor, management, and other inputs.

3.2 Variety replacement

Farmers have to abstain from other opportunities. Increased intensification and commercialization may increase the opportunity cost of maintaining crop diversity so much that farmers may not be willing to maintain it. As farmers specialize with increased market integration and availability of new technologies, the number of concerns they have associated with crop production decreased and therefore the number of traits that they consider important in their varieties decline. Although we recognize the need is recognized for mechanisms to monitor the natural and human phenomena that put plant genetic resources at risk, to assemble information and to respond appropriately, this activity is not a national priority. Moreover, standard national mechanisms used to monitor genetic erosion have not been established.

3.3 The loss of genetic diversity

The loss of genetic diversity in Thailand will continue in the future. There is also an indication suggesting that the rate of loss will not slow down even though a significant amount of mitigation activities have been implemented by private and public agencies/organizations. Institutional based activities to conserve forests, marine ecosystems and fresh–water environments will continue to require efforts to conserve biodiversity. The continuous loss of biodiversity in Thailand at such an alarming rate is mainly caused by the lack of social awareness and consciousness in preserving natural resources for the coming generations.

The prospect of biodiversity in Thailand is very much a crisis. The present survey and inventory efforts have not been able to hold back the alarming rate of genetic diversity loss. There are still many factors supporting the wasteful use of genetic diversity while supporting factors for the survey and inventory of genetic diversity are still insufficient.

The major factors influencing genetic erosion can be identified as the following:

- Lack of social awareness
- Variety replacement
- Policy and legislation change
- Economic pressures
- Over–exploitation
- Urbanization
- Environmental affects
- Methods of cultivation

When evaluating the loss of species from every natural ecosystem, it appears that, at present, the overall extinction rate is more than 30,000 species per year. From available evidence, it has been found that, prior to the appearance of Homo sapiens, the average extinction rate was one species per 4 years. Thus, the present extinction rate may be 120,000 times higher than the rate in prehistoric times and clearly indicates humans as a major cause of the increase in extinction rate. Biologists expect that, without significant conservation efforts, the Earth will lose 20% of species within the next 30 years and 50% by the end of the next century. Even though extinction is a natural process, the high rate of extinction can be considered as an unnatural phenomenon and as an indication of a crisis facing every living organism on earth. For humans, the conservation of genetic resources has greater meaning than preservation of specific species or ecosystems. Conservation is also the means to ensure the existence of the human race itself since the conservation of genetic resources is a direct measure in preserving food, medicine, and other necessary resources required for human survival. Many animal and plant species in Thailand are now placed on the endangered or rare list. Thailand was once world famous for the presence of over 1,000 species of orchid.

Drought conditions currently exist in many parts of Thailand. It is reported that Thailand has suffered major crop losses from the current drought. The Thai government has announced that 70 of its 76 provinces have been hit by drought this year (2004), affecting more than 9 million farmers and almost a million hectares of paddy fields. The 2004/05 rice crop is estimated at 17.0 million tons (25.76 million tons, rough basis), down 1.0 million tons from last year, and trade sources expected the sugar crop to drop by about 30 percent in 2004/05. The 2004 summer/autumn and 10th month crops were larger than expected due to good yields.

The loss of crop varieties may seem to be insignificant when considering the overall status of genetic diversity. However, the loss of these varieties, which are responsible for food production, is indeed a great concern for enhancing performance of varieties through selective breeding, especially when the demand for better varieties is increased by the continued reduction of cultivated land. The earliest rice cultivation is believed to have taken place in what is now Thailand. However, many wild rice species in Thailand are now extinct. At present, a limited number of the 200,000 rice varieties existing worldwide are cultivated in Thailand. Some wild fruit species such as wild durian and wild mangosteen now appear to be extinct.

4. Future needs and priorities

4.1 Financial and human resources measures and relevant policies should be given due consideration as they are crucial factors in the programme of implementation.

4.2 It is necessary that PGD be seriously considered and placed as a high priority on the country's national agenda.

4.3 Full support of activities related to the survey and inventory of PGRFA.

4.4 Policy, research, and management actions at the national, regional and global levels are needed in the following areas:

- Status of crop genetic diversity
- Understanding and supporting farmer management of crop genetic diversity in production
- Activities supporting capacity building, responsible actions and public awareness
- Strengthening the informal seed supply system
- Creating methodologies for integrating locally adapted crop cultivars and farmer preferences into development and extension projects
- Curriculum development in the formal sector (primary, secondary, extension workers, university) on the conservation and use of local crop diversity
- Integration of all individual actions in taxonomic work into national taxonomic work programmes.

Chapter 2

The State of *In situ* Management

1. PGR inventories and survey

Thailand has initiated a number of programmes in response to this activity that have already been mentioned in chapter 1. The survey and inventory of PGFRA are not the priority of the country. Therefore, some constraints for surveying and inventorying of PGRFA in the country, which still occur, are as follows:

- It is not clear which organization is responsible for conducting surveys and inventories.
- National priorities have not been established.
- Insufficient financial support.
- Insufficient number of staff.
- Staff do not have sufficient skills.
- There is overlapping of researches that lead to weakness of database management system
- There is no National Focal Point (NFP) for cooperation among concerned institutions.
- Weakness of regional collaboration.
- Lack of trained staff in surveying of PGRFA

Capacity building needs

- Human resources
- Training
- Financial support

2. On-farm management and improvement of PGRFA

A number of the institution are continuing to improve their knowledge of the dynamics and implications of on-farm conservation and plant improvement. For example, the Community Rice Center (CRC) and some community networks conduct research aimed at understanding the socio-economic and genetic dynamics of farmer-managed systems involving rice. They consider that on-farm conservation is a method of *ex-situ* conservation. Information on *ex-situ* conservation is presented in Annex 9.

There are some major constraints as follows:

- Inadequate incentives provided to farmers
- Insufficient seed or planting materials
- Insufficient financial support
- Insufficient skills and staff training
- On-farm management and improvement of PGRFA are not a national priority.
- Lack of conservation network as well as technical support
- Lack of farmer involvement in the programme
- Lack of enough incentives for involved farmers.

3. Restoring agricultural systems after disasters

In Thailand, there exists a developed breeding and seed production system as a main part of the production of common agricultural crops as well as an advanced variety-testing procedure with a long tradition and relatively intensive network of experimental stations. The system including methodology for elite seed propagation and certification of multiplication steps is not a guarantee of germplasm maintenance for contemporary (commercially grown) genetic resources in cases of disaster. On the other hand, some genetic resources of domestic origin (old non registered cultivars, local varieties, genetic lines and wild related species) are kept in both base and active collections.

In addition there has been no establishment of a mechanism of duplication between genebanks for safety. However, the government of Thailand is ready to assist or establish a standing capacity to support the restoration of agricultural systems in areas affected by disasters from community genebanks for some PGRFA. A number of community genebanks, Prachin Buri Rice Research Center (RRC), Chiang Mai Field Crops Research Center (FCRC), Chainat FCRC, Khonkaen FCRC, Nakhon Sawan FCRC, Suphan Buri FCRC, Rayong FCRC, Songkhla FCRC, Ubon Ratchathani FCRC, Biotechnology Research and Development Office (BRDO), and Community Rice Seed Center could facilitate reintroduction of germplasm following disasters. Even though these institutions are not placing high priority on collecting germplasm, it might be useful for later restoration efforts to some extent.

The greatest constraint to restoration of locally adapted germplasm following disasters in the country is that PGRFA were not collected and inventoried before the disaster. Other constraints are similar to previously mentioned ones, that is, it is not a national priority and there are insufficient training and skills of staff. Therefore, there are needs and priorities to improve PGR disaster response mechanisms as follows:

- Establish the national policy for a local supply system of germplasm following disasters
- Information sources for PGRFA.

- International support does not put emphasis on this topic. Therefore, it should be set in international organization's policies.

4. *In situ* conservation of wild crop relatives and wild plants in protected areas

A number of institutions are increasing their efforts to study and promote the conservation of genetic resources of wild crop relatives and wild plants. Several research projects have been aimed in the last ten years at supporting *in situ* conservation of PGR. Those activities of the DOA that have supported and enlarged sustainable efforts of the national programme for germplasm conservation and utilization are shown in Table 9.

Table 9 ***In situ*** **conservation of wild crop relatives and wild plants**

Name of programme/project/activity	Name of conservation area	Name of taxon
In situ conservation of wild rice	Prachinburi RRC, Sakon Nakon RRC	*Oryza rufipogon*
Edible plants in Thailand	Protected areas	*Mangifera* spp., *Garcinia* spp. and *Nephelium* spp.
Field collection of local rice varieties for breeding programmes	Phathalung	*Oryza* spp.
Community Rice Center	Suphanburi	*Oryza sativa*
Selecting, breeding and exchanging of rice varieties	Nan	*Oryza* spp.
Selection of local rice varieties	Pichit	*Oryza sativa*
Selecting, breeding of community rice varieties for their own utilization	Chaing Mai	*Oryza* spp.
Collection of local rice varieties	Surin	*Oryza sativa*
Conservation and utilization of paper mulberry genetic resources	Prao District, Chiang Mai	*Broussonetia papyrifera*
Conservation and utilization of mungbean and blackgram genetic resources	Chiang Rai, Chiang Mai, Mae Hong Son	*Vigna gracilis; Vigna minima; Vigna radiata; Vigna radiata* var. *sublobata; Vigna sublobata; Vigna unguiculata*
Conservation and utilization of wild sugarcane genetic resources (Survey, collection, evaluation and database management)	Petchaboon, Pitsanulok, Uttaradit, Lampang, Payao, Chiang Mai, Nan, Prae, Khanchanaburi, Suphanburi, Chainat, Uthaithani	*Erianthus* sp.; *Saccharum spontaneum*

Moreover, ongoing research to investigate the genetic diversities and mating systems of *Rhizophora apiculata*, *R. mucronata*, *Azadirachta* spp., some *Dipterocarpus* spp. and bamboo

species using molecular markers is being conducted. In addition, the Royal Forest Department (RFD) and DNP have initiated some activities as follows:

- The RFD coordinated 8,668 villages to develop community forests in 61 provinces. All activities had the aim of providing option to minimize negative and to promote positive human influences on forest biological diversity.
- DNP officials have studied impacts of forest fire on the management of forest biodiversity at the Forest Fire Development and Control Center near Huai Kha Khaeng Wildlife Sanctuary, the Natural World Heritage Site.
- The Forest Fire Development and Control Center is responsible for research on forest fire and its influences on the management of forest ecosystems in Thailand and coordinates among officials and researchers from Southeast Asia countries.
- DNP officials from the Forest and Plant Conservation Research Office carried out taxonomic studies and inventories on fauna and flora throughout Thailand.
- DNP coordinated research of academics and institutions on wild fauna and flora taxonomic in all protected areas throughout Thailand.

Because forest trees and wild plants, including edible plants and wild fruit trees are naturally distributed in forests, to protect these resources *in situ* involves protection of the forest in protected areas. In addition, the government has enacted the PVP Act B.E. 2542 (1999) to promote the conservation and sustainable use of local plant varieties and wild plant varieties.

Thailand has set a target to have 25% of the country's total land area as protected areas, based on the eighth National Economic and Social Development Plan (NESDP) 1997–2001. At present, protected areas declared by Royal Decrees (a responsibility of the DNP) account for 20% of the country's total land area. The system of protected areas is under development. There is a need to review the effectiveness in protecting biodiversity and legal status of all protected area types in order to establish a national system Table 10 lists the types and areas of protected areas.

Table 10 Types and Areas of Protected Areas 2004

Categories	Refer to IUCN Protected Area Category	Number	Total area	Percentage of Total Country Area
By Royal Decrees				
National Park	II	114	63,464,33	12.37
Wildlife Sanctuary	la & Ib	59	36,758.53	7.16
Marine National Park	II	27	8,627.62	1.68
Non-hunting Area	VI	55	4409.59	0.86
By Ministerial Declarations				
Forest Park	III	67	870.49	0.17
Botanical Garden	VI	15	58.96	0.01
Arboretum	VI	54	36.08	0.01

Table 10 Types and Areas of Protected Areas 2004 (Cont.)

Categories	Refer to IUCN Protected Area Category	Number	Total area	Percentage of Total Country Area
By Cabinet Resolutions				
Watershed Class 1 and 2	I, II, IV & VI		93,090.00	18.14
Conservation Mangrove	VI		428.00	0.08
Environmentally Protected Area				
International Recognitions				
World Heritage (nature)*	II	2**		
Ramsar Site	VI	10***	3,731.80	
Biosphere Reserve	VI	4	261.00+…	0.05+..
ASEAN Heritage*	II	2**		

* Total land area (sq km) is not shown because there is some overlap with other categories, e.g. national park, wildlife sanctuary, and non-hunting area.

** In terms of legal status World Heritage and Association of South East Asian Nations (ASEAN) Heritage sites are either wildlife sanctuaries or national parks.

*** 8 out of 10 Ramsar sites are protected areas.

5. Obstacles exist to improving methods for *in situ* management

- National priorities have not been established.
- Insufficient financial support.
- Insufficient number of staff.
- Some staff do not have sufficient skills.

6. *In vitro* germplasm collection and management.

In vitro propagation is applied for the medium term preservation of certain crops, mostly the economic important ones and is done in the universities for their breeding stocks and other purposes based on the interests of the institutes. Tissue culture and in combination with the growth retardants or low temperature are applied based on the facilities in the institutes. Such genebanks are mostly not link to the database and DOA. As the orchid sanctuary and a major export country of orchids, numerous species of orchid mostly *Vanda*, *Dendrobium, Paphiopedilum*, *Rhynchostylis* and *Ascocentrum* spp. are collected and the kept as the breeding materials in many laboratories and nurseries managed by the academic institutes and private companies. Germplasm exchange is performed between the organization under the Material Trasfer Agreement (MTA) both local and internationally. Furthermore, the *in vitro* germplasm technique is applied to the forest tree collection, however only in limited species. Thus human resource development as well as more financial support giving to this activity is an urgent need

Chapter 3

The State of *Ex Situ* Management

1. The state of collection

Within the agricultural region of Thailand, *ex situ* methods for conservation have been developed and reach international standards. A number of generatively propagated species are held in genebank storage at DOA (Annex 9). Conservation of vegetatively propagated crops is mainly conducted in field collections. *Ex situ* methods will further be expanded by the use of cryopreservation in the future.

Ex situ conservation is not guaranteed in the framework of the national programme and there are still some obstacles. Even though Thailand has a long-standing commitment to *ex situ* conservation and realizes the great importance of implementating this activity, there are still only a small number of institutions to assist countries for holding national collections either under "black box" arrangements or maintaining duplicates of national material in their genebanks. Most institutions routinely restore genetic resources, upon request, to national programmes. Most publications related to *ex situ* collections are in the form of hard copies.

2. Collection

DOA is regarded as a major institution responsible for research on plant breeding and conservation. DOA is, therefore, a source of agricultural plant diversity through its collections at different research centers and research stations throughout the country. These collections, comprising both plants grown in field collections and genebanks, are important sources of materials for agricultural research.

At present, DOA has established a project on conservation of genetic resources in various crops. The project involves surveying and collecting plant genetic resources as follows:

2.1 Horticulture

Surveying, collecting and setting up of field collections are conducted at 13 Horticultural Research Centers (HRC), 9 technical and production research service centers, and 3 agricultural research stations, in: 8 important fruit crops (durian, longan, longong, langsard, mangosteen, tangerine, pomelo and rambutan) comprising of 3,675 clones and 7,078 trees; 3 types of ornamental plants with potential for commercial application (torch ginger, curcuma, orchid) comprising of 309 clones and 14,109 plants; other fruits (subtropical fruit trees, temperate fruit trees, exotic fruit trees, native fruit trees, tropical fruit trees, good variety fruit trees) comprising of 33,194 plants; 9 industrial horticultural crops (cocoa, cashew nut, coconut, tea, pineapple, Robusta coffee, Arabica coffee, macadamia, Chinese chestnut comprising of 698 clones and 36,382 plants; 8 types of other ornamental flowers (gerbera, water lily, scented wood, jasmine, anthurium, chrysanthemum, banksias, hippeastrum) comprising of 800 clones and 10,759 plants; and vegetables (native vegetables, asparagus,

Dendrocalamus asper, bamboo shoots, egg plant, *Capsicum annuum* var. *annuum* (large chili), *Capsicum frutescens* var. *frutescens* (small chili), Chinese chives, morning glory, taro, sweet potato, rattan, *Parkia speciosa* (parkia), *Archidendron jiringa* (niang) comprising of 1,430 clones and 25,894 plants. Altogether, the field collections involve 8,571 clones and 127,416 plants covering an approximate area of 238 ha.

2.2 Herbal plants/rare plants

DOA has collected genetic resources of more than 700 types of herbal plants for conservation at 8 research stations/research service centers as follows:

Tak Province, 455 types; Phrae HRC, 102 types; Trang HRC, 282 types; Yala HRC, 66 types; Nongkhai HRC, 154 types; Srisaket HRC, 168 types; Nakhon Phanom HRC, 70 types; Chumphon HRC 518 types.

2.3 Wild orchids

Survey, collection and identification have been conducted at seven research centers/research service centers, and 273 species have been identified from 23 genera. For example, 150 specimens were determined at the HRI of which 91 species were identified in 27 genera; Chiang Rai HRC, identified 49 species from 22 genera; Srisaket HRC, identified 127 species from 40 genera, Trang HRC collected 60 species of which 19 from 17 genera were identified; Chanthaburi HRC collected 60 samples of which 39 species were identified from 27 genera; and Yala Research Center collected 50 species of which 15 species were identified.

2.4 Field crops

Genetic resources have been collected in field crops such as cassava, sugarcane, wild sugarcane, jute, roselle, Cuban kenaf, ramie, paper mulberry, maize, soybean, mungbean, pigeon pea, peanut, sesame, cotton, cowpea, rice bean, bambara groundnut, sorghum, sunflower, castor, kapok and others. The genetic resources of field crops comprises 24 species and 11,472 accessions from 20 research centers such as FCRC at Nakhon Sawan, Chai Nat, Chiang Mai, Khon Kaen, Ubon Ratchathani, Songkhla, Suphanburi, Nakhon Ratchasima and Rayong.

2.5 Rice

A total of 24,369 accessions of rice genetic resources are being conserved in the DOA genebank (Sirindhorn Plant Genetic Resources Building). Further survey and collection in 2004 resulted in 10 more samples of wild rice from Phrae, Nan, Phayao, Chiang Mai, Lampang; 61 samples of cultivated rice from Mae Hong Son, and 68 samples of trade rice from Chiang Mai, Nakhon Ratchasima, Nakhon Nayok and Nakhon Srithammarat were accumulated.

2.6 Para rubber

A total of 4,709 para rubber cuttings were collected and grown in the field collection of Chachoengsao Rubber Research Center, comprising 1,697 introduced wild varieties, 111 cultivated varieties and 2,901 Thai hybrid varieties. At Songkhla Rubber Research Center there were 806 samples including 765 introduced wild varieties, 7 varieties introduced from overseas, and 34 Thai hybrid varieties. At Nongkhai Rubber Research Center there were 647 samples including 463 introduced wild varieties, 20 cultivated varieties, and 164 Thai hybrid varieties.

3. Types of collection and storage facilities

There are four types of storage facilities, i.e., long-term, medium-term, short-term seed storage, and *in vitro* conservation. Storage conditions are different among these facilities (Table 11). Numbers of accessions stored under the specified storage conditions of each institutions are shown in Annex 10.

Table 11 Types of storage facilities

Institute	Type of storage facility	Minimum temperature	Maximum temperature	Minimum humidity	Maximum humidity	Minimum moisture content	Maximum moisture content
BRDO	Medium term seed storage*	4	5	35	50	8	12
BRDO	Long term seed storage*	-10	-8	35	50	6	8
BRDO	*In vitro* conservation unit	20	25	50	70	80	95
FCRI	Short term seed storage*	15	18	-	-	-	-
FCRI	Medium term seed storage*	4	5	35	50	8	12
FCRI	Long term seed storage*	-10	-8	35	50	6	8
FCRI	*In vitro* conservation unit	25	-	-	-	-	-

Note: The temperature is in degrees Celsius.
* DOA genebank.

3.1 Orthodox Seed Storage

Seeds can be dried without harm to seed viability and conserved in storage rooms. Seed storage rooms are located in various DOA research centers and other organizations in both public and private sectors. Seed is kept at temperatures ranging from 15-20 ºC for short-term storage. At the DOA genebank, there is a seed storage room for medium-term storage with a temperature of approximately 5 ºC and a room for long-term storage with a temperature of approximately -10 ºC. Types of seeds stored in the genebank are mainly rice, both cultivated and wild. In addition, storage rooms are also used for field crops, such as maize, mung bean,

soybean, peanut, cowpea, pigeon pea, jute, roselle, kenaf, cotton, sesame, and castor, and for some vegetables, e.g., Chinese morning glory, yard-long bean, chili, okra, etc. Seeds to be kept in the storage rooms must be recorded, cleaned, and tested for germination and moisture content. Seed germination and viability must be tested periodically during storage. Low germination or low viability accessions will be rejuvenated.

a) Rice:

About 24,000 accessions of rice genetic resources, both cultivated and wild types, are conserved in the medium- and long-term storage rooms at the DOA genebank. Most of them are traditional varieties, and some wild accessions are ancestors of cultivated rice.

b) Field Crops:

Field crop genetic resources comprise 2,250 accessions of mungbean, 2,030 accessions of peanut, 1,510 accessions of soybean, 85 accessions of cowpea, 118 accessions of pigeon pea, 385 accessions of cotton, 36 accessions of ramie, 120 accessions of kenaf, 160 accessions of jute, 200 accessions of roselle, 390 accessions of sesame, 30 accessions of safflower, 147 accessions of castor, 1,036 accessions of maize, 214 accessions of specialty corn and 100 accessions of sorghum All of these accessions are conserved at the DOA genebank and at different FCRC of DOA.

c) Horticulture:

There are 8 types of vegetable seed, i.e., Chinese morning glory, yard long bean, chili, tomato, okra, and various types of *Solanum* spp. conserved in the medium- and long-term storage at the DOA genebank. Some accessions are in short-term seed storage at different HRC of DOA.

3.2 In vitro collection

a) Rice:

In vitro conservation of 224 and 28 plants of wild rice, *Oryza granulata* and *O. ridleyi*, respectively, has been conducted at the DOA genebank.

b) Field crops:

In vitro conservation of 609 samples of cassava using tissue culture techniques has been conducted at Rayong FCRC.

c) Horticulture:

Most research activities are at the stage of developing techniques for conservation under sterile conditions. Research has been carried out on various types of horticultural plants, for examples, fruit trees such as rambutan, tangerine and leech lime (*Citrus hystrix*), banana, wild

orchids such as ueang ngoen luang (*Dendrobium formusom*), ueang pak nok kaew (*Dendrobium ellipsophyllum*), lin kra bue (*Excoecaria cochinchinensis* Lour.) and chang saraphi (*Acampe longifolia*). Seed storage of these wild orchids using liquid nitrogen methods has been studied.

Conservation of native and endangered plants of ground orchids (*Spathoglottis* species) including *S. plicata* Blume, *S. plicata* Gagnep, *S. affinis* de Vriese and *S. pubescens* Lindl. has been done using tissue culture for 400, 400, 385, and 120 plants, respectively. In addition, other species of wild orchids have been cultured in 448 bottles.

A total of 15 samples of GMO papaya were collected and cultured on medium for slowing plant growth *in vitro*.

4. Security of stored material

Capacity for regeneration is always considered when assembling collections and disseminating accessions. According to a report, more than 8,000 PGRFA accessions need to be regenerated (Table 12), representing 55.5 % of all collections. Some institutions have carried out this activity to reduce genetic changes or losses of genetic integrity (Table 13). Moreover, there is a project on conservation and utilization of soybean genetic resources. The project is concerned with genetic change or loss of genetic integrity during regeneration because of low viability of regenerating samples and selection pressures from unsuitable environments.

Table 12 Regeneration of PGRFA

Stakeholder	Name of regeneration project(s)	Name of crop/crop group	Priority status	Number of accessions in need of regeneration	Number of accessions already regenerated according to established standards	Estimated number of years required to complete regeneration
BRDO, RRI	Conservation of rice genetic resources	Rice	Priorities not yet set	12000	8000	3
Nong Nooch Tropical Botanical Garden	Collection Rejuvenation, Conservation and Evaluation of Zingiberales Genetic Resources	Zingiberales	Priorities not yet set	2165	2165	5
Nong Nooch Tropical Botanical Garden	Conservation and utilization of *Annona* crop and genetic resources (Survey, collection, evaluation and database management)	*Annona*	Priorities not yet set	19	19	5
Nong Nooch Tropical Botanical Garden	Conservation and utilization of Guava crop and genetic resources (Survey, collection, evaluation and database management)	*Psidium*	Priorities not yet set	14	14	5
Nong Nooch Tropical Botanical Garden	Conservation and utilization of Mango crop and genetic resources (Survey, collection, evaluation and database management)	*Mangifera*	Priorities not yet set	281	281	5
FCRI	Conservation and utilization of soybean genetic resources (Survey, collection, evaluation and database management)	Soybean, Soya	Priorities are set and activities are underway	500	277	3

Table 13 Management of genetic changes or losses of genetic integrity

Stakeholder	Management practices
BRDO	Timely viability testing; Suitable regeneration environment; Proper handling of regenerated material
Nong Nooch Tropical Botanical Garden (S-216-12)	Suitable regeneration environment; Adequate isolation; Adequate population size; Proper handling of regenerated material
Chiang Mai University (S-216-13)	Timely viability testing; Suitable regeneration environment; Adequate population size; Proper handling of regenerated material
Local Community Regening Group (S-216-26)	Adequate isolation
FCRI	Timely viability testing; Suitable regeneration environment; Adequate isolation; Adequate population size; Proper handling of regenerated material

5. Documentation and characterization

5.1 Documentation

Data concerning *ex situ* conservation have been recorded. The data, both raw and analyzed, consist of basic data, data on identification and evaluation of plant characteristics, data on rehabitation, request data, and distribution data. These data have been distributed in both printouts and through the internet.

5.2 Characterization

Each plant variety was studied and evaluated for their morphological and genetic characteristic using both biomolecular techniques and morphological studies. Some of the information is presented in Annex 11. Characterization has been conducted of economic values and morphological traits of stems, leaves, flowers, fruit and seeds of plant varieties in the field collection. A DNA fingerprinting technique was used for identifying typical characteristics of the plants.

a) Horticulture: Characterization was conducted on 13 types of plants, namely ma-poot (*Garcinia dulcis*), pawa (*Garcinia speciosa*), gamboge tree *Garcinia hanburyi*, durian, hybrid durian, rambutan, jackfruit, longon (*Lansium domesticum* Corr.), orange, robusta coffee, aromatic coconut, makapuno, torch ginger and orchids.

b) Native plants in the eastern region: DNA amplification was conducted using Touchdown PCR (Polymerase Chain Reaction) with 100 ISSR (Inter-simple Sequence Repeat) primers. The RAPD technique was then used for testing 250 other primers. Results are in the process of being analyzed. For pawa, DNA amplification using gradient annealing PCR with 350 primers was studied, for which 13 primers were determined.

c) Fruit trees: Studies involve 30 varieties and 62 plants of native durian.

d) Ornamentals & flowers: Studied were conducted on *Anthurium*, *Curcuma*, torch ginger and new *Dendrobium* hybrid varieties. At least 10 varieties resulted from establishing a database on the genetic resources of *Dendrobium* orchids for commercial purposes in Thailand.

6. Germplasm movement

6.1 Exchange of genetic resources

Most institutions imported plants from overseas for research purposes during the period of 1965-1994 as follows: fruit trees, 25 types; vegetables, 6 types; ornamental flowers, 3 types; industrial horticultural crops, 5 types and herbal plants, 1 type.

6.2 Registration and certification

During the period 1998-2001, a total of 53 horticultural varieties from the plant improvement programme of both private and public sources, were brought for registration according to the Seed Act 1975 and 1992. There were 30 fruit trees, 3 ornamental plants, 6 industrial horticultural plants, 10 vegetables and 4 tuber plants.

From 1972-2003, DOA has registered and certified the following plant varieties: vegetables, 9 certified varieties and 4 recommended varieties; industrial horticulture, 6 certified varieties and 6 recommended varieties; fruit trees, 11 recommended varieties. In addition, 60 horticultural varieties are being investigated for their values as recommended varieties.

7. Role of botanical garden

7.1 School botanical gardens

A school botanical garden project is running for conservation, study and utilization of plants in schools. School botanical gardens have been established as part of a project on plant genetic resources conservation under the Royal Patronage of Princess Maha Chakri Sirindhorn. The project aims at raising public awareness on the conservation of PGR. Activities consist of placing names on existing trees and growing more trees, finding information about existing trees and writing reports concerning local wisdom and utilization of the trees. At present, members of the school botanical garden project include not less than 572 schools distributed in 13 educational regions in 66 provinces. A network of schools with botanical gardens has been set up by which schools are connected to each other through the internet.

7.2 National botanical gardens

Throughout the country, there are 7 botanical gardens, 54 arboreta, 4 literary botanical gardens and 4 special gardens. The objectives are to:

- collect living plants either native or exotic to Thailand for botanical research
- conserve and propagate native plants, particularly rare, endemic and economically important species
- act as collection centers of herbarium specimens
- act as education and recreation centers for tourists and local people, for pleasure and to raise environmental awareness.

7.3 Queen Sirikit Botanic Garden (QSBG)

The QSBG Plant Conservation Strategy was launched in 1997, comprising 7 programmes, namely, living plant collections, herbarium collections, seed collections, *in vitro* collections, documentation and database, education, and collaboration. It aimed to provide the first stage guidelines for the development of an action plan for plant conservation activities at QSBG.

Some programmes have already been implemented, e.g., *in vitro* conservation, while others require the availability of resources, as well as a team effort from various disciplines.

8. Major constraints on *ex situ* conservation

The major constraints to implementing *ex situ* conservation activities are as follows:

- Lack of funding
- Insufficient staff
- Lack of training
- Lack of a focused approach
- Insufficient equipment
- Insufficient or irregular electrical supply

9. Major *ex situ* needs

- Regular regeneration of *ex situ* collections.
- Efficient workers for this type of work which is tedious and time consuming.
- Support from FAO to help get enough budget from either local government or international funding agencies.
- Training and exchange of methodology to solve the regeneration of threatened plants
- Requirement for international exchange of PGR.
- Adequate computer equipment and software programmes for database establishment.
- Equipment for Global Positioning System (GPS) to be used in survey and recording the distribution of PGR

Chapter 4

The State of Use

1. The importance of utilization

1.1 Distribution of PGR

Available plant materials together with characterization and evaluation data is the main indicators of PGR usability. Evaluation of PGR collection (including characterization) has been carried out regularly and the results of every year experiments are assessible according to national annual research lists. Characterization of genetic resources is being broadened particularly by morphological traits, characteristics of storage proteins and isoenyzmes, and development of techniques using molecular genetics and DNA markers.

The percentage of accessions presently characterized and/or evaluated using the various types of descriptors is defined in Annex 11.

2. Utilization activities

2.1 Utilization and enhancing the use of PGR

a) Under-utilized crops

Even though this area of activity is of low-medium priority, planning without initiation, a number of the Stakeholders (SHs) actively support the conservation and use of under-utilized crops to contribute to food security and rural development, particularly in marginal areas, and for agricultural diversification. Some SHs are seeking to identify wild crops that have not previously been used for food and agriculture. DOA and RFD have promoted the *in situ* management and use of these plants within the country for a number of years, and have carried out some activities (Table 14). Moreover, DOA has also promoted and planned to expand this area of work to the conservation and use of neglected and under-utilized crops, especially of herb species, wild rice, herbal and medicinal plants, wild relative of tropical fruit crops, wild relatives of vegetables and wild *Vigna*.

Non-traditional and neglected crops are becoming very popular as healthy food alternatives and often become components of bio-products, and increasing demand in the markets. Establishment of contracts between farmers and producers of final products is very important for broadening the growing of neglected crops. Collaboration between organic farmers and companies that processing the products and put them to the market is now increasing. Collaboration between growers (mainly community farmers) and the trade company, which processes and markets such products, has recently increased in Thailand. Sustainable utilization of neglected crops is supported in Thailand mainly in indirect ways. One way is through state financial support of research projects that evaluate characteristics and properties of neglected crops from the point of view of their utilization in growing, product processing

and marketing. A number of selected genotypes improved by breeders have been registered and are recommended for growing.

Table 14 Activity related to the development or commercialization of under-utilized crops or species

Name of programme/project/ activity	Target	Name of crop	Topics covered
Conservation of local rice varieties	Local varieties	Rice	Crop improvement; Public awareness
Edible plants in Thailand	Local varieties	*Amomum* spp.	Public awareness
Breeding, selection, collection of community rice	Local varieties	Rice	Crop improvement; Seed distribution; Public awareness
Community Rice Center	Under-ultilized crops or species; Local varieties; 'Diversity-rich' products	Indigenous rice	Seed distribution; Improving processing; Market development; Public awareness

The increasing uniformity in the agricultural market place is usually the result of the promotion of new and improved varieties that are widely adapted, concentrate on productivity, and that are crops for global consumer markets, as well as changes in traditional cultures and consumer preferences. Better market opportunities and supportive policies for local and locally adapted and under-utilized crops and species increase the incentive for farmers to continue to use these crops and species and thus to conserve biodiversity. They also help to maintain local knowledge concerning the management and uses of these crops and species. Many local and under-utilized plants have potential for more widespread use, and their promotion could contribute not only to local income generation, but also to food security and agricultural diversification, particularly in areas where the cultivation of major crops is economically marginal. The government encourages current programmes for conservation, research and development to promote these crops and species.

b) Promotion of breeding programmes

Thailand promotes and facilitates the use of greater diversity in breeding programmes and in varieties and species grown on-farm to reduce the vulnerability and increase the stability of agricultural systems. In this regard, the PVP Act was enacted in 1999 to encourage breeders and farmers to use 35 local and wild plant varieties in their breeding and farming programmes for developing new varieties of plants (Table 6 in Chapter 1) As a result, the breeder as a rights holder of a new plant variety shall have the exclusive rights to produce, sell or distribute in any manner, import, export or possess for the purpose of any of the said Acts the propagating material of a new plant variety and the farmers shall have a rights to keep such materials for their own planting.

Some institutions continue to focus their efforts on providing improved populations as opposed to finished cultivars. DOA, for example, is emphasizing the delivery of improved rice and fruit crop populations targeted to different agro-ecological conditions all over the country. Moreover, they are expanding the range of crops they are working with, although financial constraints present a barrier.

c) Increased pre-breeding activities

Over the past decade, a number of institutions have paid significant attention to genetic enhancement and base broadening efforts, and recognized the importance of such efforts to sustainable agriculture and food security worldwide. For example, DOA has promoted the distribution and use of improved germplasm in various of crops that were already described in the *in situ* and *ex situ* activities. A number of researches, which have been estimated to be of from medium to high importance for improvement in terms of food security for specified agroecological zone/farming systems with different rationales for each activity, have been carried out for increasing genetic enhancement and base-broadening (Annex 12).

Although the activities are not a national priority, there are still some projects that support prebreeding programmes and these are listed in Table 15.

Table 15 Genetic enhancement programmes

Name of programme/project/activity	Name of taxon	Type of activity
Hybridization and Progeny Selection in Floating and Deepwater Rice	*Oryza sativa*	Genetic enhancement by introgression for specific traits; Population improvement through incorporation or base broadening
Conservation and utilization of *Annona* crop and genetic resources (Survey, collection, evaluation and database management)	*Annona* sp.	Population improvement through incorporation or base broadening
Conservation and utilization of Guava crop and genetic resources (Survey, collection, evaluation and database management)	*Psidium* sp.	Population improvement through incorporation or base broadening
Conservation and utilization of Mango crop and genetic resources (Survey, collection, evaluation and database management)	*Mangifera* sp.	Population improvement through incorporation or base broadening
Collection Rejuvenation, Conservation and Evaluation of Zingiberales Genetic Resources	*Zingiber* sp.	Population improvement through incorporation or base broadening
Conservation of indigenous rice	*Oryza sativa*	Population improvement through incorporation or base broadening
Breeding programme for high yield and quality in sesame	*Sesamum indicum*	Genetic enhancement by introgression for specific traits
Soybean breeding programme	*Glycine max*	Genetic enhancement by introgression for specific traits; Population improvement through incorporation or base broadening
Cassava breeding programme	*Manihot esculenta*	Genetic enhancement by introgression for specific traits; Population improvement through incorporation or base broadening
Conservation and utilization of maize genetic resources (Survey, collection, evaluation and database management)	*Zea mays*	Genetic enhancement by introgression for specific traits Population improvement through incorporation or base broadening

Moreover, utilization for plant improvement of 8 types of fruit trees (durian, pineapple, mango, papaya, pomelo, litchi, tangerine, lime), 6 types of ornamental flowers (Siam tulip, anthurium, torch ginger, chrysanthemum, lily, gerbera), 5 types of industrial horticultural plants (oil palm, coffee, coconut, macadamia, tea), 12 types of vegetables (potato, garlic, onion, red onion, asparagus, tomato, chili, okra, garden pea, sweet potato, taro, mushroom) 6 types of herbal plants (pepper, turmeric, vanilla, cinnamon, betel nut and *Garcinia atroviridis*) both by normal methods and by using biotechnology to characterize their genetics is being conducted.

Selection was based on the best varieties or those that have potential for use in commercial elite lines: used as stock, varieties were selected for resistance to disease and insect pests, used for suitability for processing, used for plant extracts for pharmacological purposes.

d) Diversity-rich products

In the past 10 years, Thailand has not undertaken a great deal of work in the area of new markets for local varieties and 'Diversity-Rich' Products and many people feel they have no particular “comparative advantage” to offer. Nevertheless, some people are involved in activities to encourage farmers to grow distinct, local varieties. For example, DOA supports activities to establish and expand market in sesame and rice.

Since 2001, the government has promoted the ‘One Tambon One Product’ (OTOP) programme to improve the use of locally available resources and produce goods that are acceptable internationally in order to help encourage and promote tourism in Thailand down to the village (tambon) level and increase rural income from the sale of their products. The DOAE is responsible for the support of over 10,000 OTOP groups supported by a governmental programme, and are successfully marketing locally specific agricultural products. They are producing, processing and/or marketing agricultural products, such as local fruits, rice, soybean, sesame, coconut, and corn.

The project has been conducted to increase understanding of the context in which potential good practice functions and the impact it has on people’s livelihoods and on agrobiodiversity maintained on farms. Recently interest has increased for the creation of direct economic incentives by improved marketing of agro biodiversity products. This approach, in which forward market linkages are created by processing a range of products of different varieties, is considered to have high potential. Especially among perennial species, the monitoring of on-farm management and use of biodiversity has been insufficient and this is certainly the case for these market-based approaches.

A number of member communities are rich in medicinal plants. Many small collections have been assembled by government agencies, but the sites are widely scattered in remote areas. It warrants improved communication and exchange among the workers in the interest of security. Tissue culture can help in mass propagation. The scientific basis of their claimed values needs to be undertaken first, however.

The people of Thailand have used herbs and medicinal plants as sources of drugs for traditional remedies of ailments throughout this country’s long history. Hence, ethnomedicine

has been developed and has evolved, tested through time, into the intricate art of folk medicine. Such indigenous knowledge has been perpetuated by being passed down from generation to generation within ethnic tribes. For instance, *Curcuma longa* Linn., has been used for treatment of peptic ulcer and dyspepsia, *Diospyros mollis* Griff., has been used to eliminate hookworm and *Clinacanthus nutans* Lindau, is used for treatment of burns, eczema and herpes simplex. The best known example is *Croton sublyratus* Kurz (Family Euphorbiaceae) which has been used by local people for a long time as an effective treatment for peptic ulcer. Nowadays it is known to contain plaunotol, an acyclic diterpene group of natural products. It is estimated that more than 800 species of plants contain bioactive organic compounds, which might be useful as pharmaceutical products.

Descriptions on palm leaves concerning herb usage in folk medicine (Samud Khoi, in Thai), by various ethnic groups, is evidence that the ancestral inhabitants of this region had developed their own systems of traditional medicine long ago. These ancient descriptions of folk medicine are most valuable documents in the development of traditional Thai medicine and Thai medicinal plants. Thai people have made use of these local bioresources as food, medicine, clothing and housing to support their living. The development of civilizations and cultural evolution has had a synergistic relation with the natural biological world that has long been taken for granted.

Promoting the expanded use of such crops will require capacity-building for farmers, local communities, scientists and extension specialists in identifying under-utilized crops with potential for increased sustainable use, the development of sustainable management practices, developing post-harvest processing methods and developing marketing methods.

e) Increased collaboration

Utilization for exchange of genetic resources: The HRI and involved institutions imported horticultural plants from overseas for research purposes during the period 1965-1994 as follows: fruit trees 25 types, vegetables 6 types, ornamental flowers 3 types, industrial horticulture 5 types, herbal plants 1 type.

Utilization for plant registration and certification: during the period 1998-2001, a total of 53 types of horticultural plants, which had been selected or were the results of plant improvement from both private and public sources, were brought for registration according to the Plant Variety Acts of 1975 and 1992, of which there were: fruit trees 30, ornamental plants 3, industrial horticulture plants 6, vegetables 10, and tuber plants 4.

From 1972-2003, the HRI registered and certified plant varieties such as: vegetables, 9 types as certified varieties, 4 types as recommended varieties; industrial horticulture, 6 types as certified varieties, 6 types as recommended varieties; fruit trees, 11 types as recommended varieties. An additional 60 horticultural plant types are still being investigated for their values as recommended varieties.

f) Promoting the use of landraces

There is a supplementary measure to create and maintain rice with specific varieties traditional to Thailand in order to ensure the survival of this unique resource as a large proportion of the agricultural land area of Thailand is used as paddy fields. While modern rice species have replaced older species and landraces, a number of local rice varieties can still be found in Northeast Thailand, with their characteristics described by local people along with their relationships with the way of life of the local people. These traditional varieties can still be useful as sources of breeding material in current rice breeding programmes (Annex 13). In addition, many local varieties are stilln popular for growing in each province throughout the country (Annex 13).

At present, there are several knowledgeable and competent farmers who are working on the conservation, selection and breeding of local rice. More than 30 rice varieties have been collected. These farmers not only practice what they have learned in their fields but also teach other farmers. More than 100 farmers in various geo-ecological areas are interested in growing and improvement of local rice in their fields.

A farmer network in local rice genetic conservation and development is in the process of encouraging other farmers, improving their techniques, and sharing related political issues, problems and impacts. Although some farmers could analyze and understand the relationship of the issues with their work, most of them could not because the learning process requires time for comprehension. Consequently, in the future, the direction of the network will be focused on providing the learning process, information about related political issues and impacts. It is also planned to expand activities to other local vegetable and medicinal plants as well as local animal strains. Hopefully, this would increase bio-diversity in the field and bring back a sustainable and sufficient agriculture system in farmer's fields.

A survey by the Office of Agricultural Economics found over 10 million rai (1.6 million ha) of traditional rice varieties were still grown throughout the country in 1997. For efficiency in the production system as well as long-term prospect for *in situ* conservation it will be useful to identify how much of the current traditional rice area has resulted from inertia from the extension process and how much has resulted from real biophysical, economic, and social constraints. The rice area under traditional varieties is spread through all four regions. Some areas, e.g. Chainat, Surin, Hantra in Ayuthya, and Koksamrong in Lopburi, are among the country’s oldest and most famous rice research stations where several improved rice varieties have been developed. In other words, lack of access to improved varieties is not likely to be the main reason for continued use of many local varieties.

g) Participation in breeding programmes

Some activities have been carried out with various objectives, to enhance the quantity of high quality seed in order to satisfy farmers, demands, to be the developing center of production and marketing, to be the center for transferring appropriate technology at the community level, and to increase yield and get better quality. All activities support seed production and distribution (Annex 13).

h) Characterization and evaluation

Characterization and evaluation of PGR are carried out regularly and the results of experiments with PGR every year are assessed according to National Annual Research lists. Characterization of genetic resources is being broadened particularly using morphological traits, characteristics of storage proteins and isoenyzmes, and mainly with development of techniques that use molecular genetics and DNA markers.

The characteristics of each variety were studied and genetic characteristics were then evaluated. Identification used both biomolecular techniques and morphology. A study on economic values was conducted. Studies of stems, leaves, flowers, fruit and seed of varieties in field collections were conducted and the DNA fingerprinting technique was used for identifying typical characteristics of plants.

There are 12 species for which characteristics are being identified and evaluated for their values, namely rice, sugarcane, wild sugarcane, soybean, cassava, animal feed corn, corn for human consumption, sesame, peanut, mungbean, pigeon pea, rami and castor oil. The identification of characteristics of some has been finished and others are almost finished. Mostly, it is the identification and evaluation of morphological traits and agronomic traits that has been done as summarized in what follows**.**

There are 6 types of plants for which their genetic resources have been completely identified in terms of morphological traits and evaluated for agronomic traits, namely sesame, peanut, mungbean, pigeon pea, rami and castor oil. The remaining 6 types of plants that have had more than half identified are rice, sugarcane and wild sugarcane, soybean, cassava, corn for animal feed and corn for human consumption. In wild sugarcane, about 50% of genetic resources have been identified using molecular markers, in cassava 25%, and in soybean, sugarcane and mungbean only 5%, 2% and 2%, respectively.

The genetic resources that have been evaluated for their biochemical traits focus on outstanding characteristics of each plant and not all chemical components, e.g., for oil crops the focus is mainly on oil content, for legume crops the focus is on protein content, for energy-providing plants the focus is on carbohydrate or sugar content. In conclusion, 9 species from 12 have had biochemical traits identified. Castor oil is the only plant species that has biochemical traits completely evaluated for all available genetic resources. There are 4 plant species for which genetic resources have been evaluated half or more than half, namely sesame, soybean, mungbean, and corn for human consumption. The rest have had less than half of their genetic resources evaluated, namely rice, peanut, pan rami, sugarcane, wild sugarcane, cassava, corn for animal feed and pigeon pea.

There are 5 plant species for which half or more than half their genetic resources have been evaluated for abiotic stresses, namely soybean, mungbean, corn for animal feed, corn for human consumption and castor oil. Rice, sesame and cassava have been evaluated less than half. For the rest, i.e., peanut, rami, sugarcane, wild sugarcane and pigeon pea, their genetic resources have not been evaluated.

For 3 species of plants, that is, soybean, mungbean and corn for human consumption, half or more than half their genetic resources have been evaluated for biotic stresses. Less than half of the genetic resources of rice, sesame, sugarcane, cassava, and corn for animal feed, has been evaluated. The genetic resources of peanut, pan rami, wild sugarcane and pigeon pea have not yet been evaluated. Only the genetic resources of castor oil have been completely evaluated.

Ten species of plant, namely rice, sugarcane, cassava, corn for animal feed, corn for human consumption, soybean, mungbean, peanut, black gram, cotton and sesame have had morphological traits, agronomic traits and biochemical traits identified, and have been evaluated for biotic stresses (resistance to diseases and insect pests). There are 7 plant species that have been evaluated for abiotic stresses (tolerance to saline soil, acid soil, or to drought), namely sugarcane, cassava, soybean, cotton, corn for animal feed, corn for human consumption, mungbean, and black gram

Horticulture: 13 types of plants, namely ma phut (*Garcinia dulcis, G. vilersiana*), phawa (*Garcinia speciosa*), rong gum cambodge tree (*Garcinia hanburyi*), durian, hybrid durian, rambutan, jackfruit, longon, orange, Robusta coffee, coconut, torch ginger and orchids.

Native plants in the east such as ma phut; DNA amplification was studied using Touchdown PCR with 100 ISSR primers and then the RAPD technique was used for testing using 250 other primers. The results are in the process of being analyzed. For phawa, DNA amplification using gradient annealing PCR with 350 primers was studied of which 13 primers were determined. At present, the results are being analyzed.

For fruit trees such as native durian**,** 30 varieties and 62 plants. Ornamental flowers such as *Anthurium*, *Curcuma*, torch ginger and new *Dendrobium* hybrid varieties for commercial purposes of which at least 10 varieties were the results from researching a database on the genetic resources of *Dendrobium* orchids for commercial purposes in Thailand.

Industrial horticulture: such as Robusta coffee, coconut. Herbal plants/rare plants: herbal plants in the Family Zingiberaceae. the rhizomes of 30 species of herbal plants were collected and planted within the same areas of 5 service centers. Genus *Dioscorea* 17 samples. Herbal plants / rare plants: phung talai (*Scaphium scaphigerum*), 20 plants were collected. Native vegetables: 13 species.

Rice: a total of 289 samples had data of identification characteristics collected. The rice was then harvested to evaluate characteristics (field rice 242 samples, wild rice 47 samples). 134 samples of harvested rice were grown for propagation. Combined data of physical and chemical qualities comprised 1,000 samples. Combined data testing reaction to disease comprised 538 samples and testing for reaction to insects comprised 383 samples. Total planting area for evaluating characteristics and values was 2.4 ha in 25 centers/stations.

Rubber: rubber genetic resources in the field collection at Ranong Service Center comprised 10 fields and 1,493 samples, at Nong Kai Rubber Research Center, 230 samples, and at Suratthani Rubber Research Center, 906 samples.

There are 21 projects with 6 groups of plants involved with determining characteristics for identification or evaluation of genetic resources: cereal group for 4 plants, namely rice, maize, sugarcane and wild sugarcane; tuber group, namely cassava; legume group, namely soybean, peanut, mungbean, black gram and pigeon pea; oil plants, namely sesame and castor oil; fiber plants, namely cotton, ramie and paper mulberry; mulberry and silk group, such as mulberry and silk. The genetic diversities of 18 species in the wild tree group have been studied using isoenzyme marker and DNA markers.

An information technology system was set up as a database for rice genetic resources. Data of 15,000 samples of rice concerning their characteristics, identification and evaluation, including sample information is now available. Of the genetic resources of 20,000 samples of rice that had been collected in a project on conservation and rehabilitation of rice genetic resources, 15,000 have been distributed at least 1 time.

At present, descriptive data (to various extents) were available for 70 % of all genetic resources gathered in the collections.

i) Capacity in plant breeding

Even through there are a number of breeding progammes, it is not clear if each institution has formulated its goals. Research institutions have been involved in plant breeding for up to 90 years and plant biotechnology for 20 years, whereas universities have been involved in plant breeding up to 36 years and plant biotechnology for 24 years. In comparison, private companies have been involved in plant breeding and biotechnology for 33 and 30 years respectively.

The total number of scientists involved in plant breeding increased in number from 92 in 1985 to 239 in 2004. Scientists with Masters degrees increased at a high rate. As a result, in 2004 the number with Masters degrees was almost equal to the total number of scientists with Bachelor and Ph. D. degrees. The number of scientists involved in plant biotechnology had also increased from 12 in 1985 to 97 in 2004. The average number of scientists at each level is similar with about 30 scientists each in 2004. Budgets declined for almost every crop during a period of five years.

The percentage of breeding activities was similar for each crop throughout the period 1985-2004 with rice comprising on average 29 percent of total activity followed by miscellaneous crops (para rubber, sugarcane, oil palm, and tobacco), fruits and vegetables, and maize at 23, 15, and 11 percent respectively.

In terms of resources allocated to each crop, line development and line evaluation comprised a higher percentage than germplasm enhancement in all crops. Resource allocation to line development and evaluation from 1985 to 2004 showed a consistent trend: however, there was a trend to increase proportion of resources allocated to plant biotechnology from 1985 to 2004, with decreased resource allocation to germplasm enhancement.

Activities using tissue culture comprised the highest proportion (33%) followed by molecular characterization (18%) and marker-assisted selection. In the biotechnology are, gene isolation had the lowest proportion at 3.30 %.

Analysis of breeding activity for each crop in 2004 revealed that rice and maize showed highest activity, while barley and wheat showed very low activity. For breeding programmes in 2004, plant breeders utilized roots and tubers, fiber crops and other grain legumes from local germplasm banks in proportions of 93, 60 and 52 percent respectively, while the Consultative Group on International Agricultural Research (CGIAR) genebank contributed 50 percent each to wheat and barley breeding.

A comparison of the overall environment for breeding from 1980 and 2004 revealed that breeding priority in 1980 seemed mostly medium to low, whereas in 2004 it showed high to medium priority, especially in maize, rice and wheat. Numbers of varieties released from 1980 to 2004 increased almost every period for rice, maize, sorghum oilseeds, fruits and vegetables. In contrast, the number of released varieties for wheat, barley and fiber crops decreased.

For assistance needed by organizations, the majority of respondents ranked the facilition of germplasm exchange and the promotion of training programme on biotechnology tools as being of high and medium high priority. Medium and medium low priority were given to promoting training programmes on conventional breeding methods and facilitating access to new biotechnological tools, respectively, while strengthening national programme capacity through investments was given low priority.

j) Future research priorities to enhance the use of PGRFA

The research plan for conservation of genetic resources of plants, microorganisms, insects, mites and animal pests, and natural enemies in the period 2006-2010 includes the following projects:

- Study and survey of the genetic resources of plants, microorganisms, insects, mites and animal pests, and natural enemies by the HRI, BRDO (Division of Plant Conservation), Office of Regulation, Office of Plant Protection Research, Office of Postharvest, 9 service centers, 1 FCRC, 8 HRCs, and 1 office of research and development of agriculture region. The work includes surveying, collection, identification, study of morphological characteristics, establishing a database about plants and their utilization as well as summarizing and reporting.

For native, rare and endangered plants such as tropical fruits, native orchids, local plants, plants in the Families Geoneriaceae and Baisaminaceae, plants in community forests, plants in the basil family, native ornamental flowers, local herbs used by the Morgan tribe, plants of the ginger family, native water lilies, ferns and fern allies for commercial use, ferns near tourist areas, wan mahanek (*Curcuma aeruginosa*), plants in the genus *Trichosanthes* (Cucurbitaceae), parasitic plants, wild orchids in deciduous forest, weeds, panjakhan (=herbal plant), and plants in the yam family.

Rice genetic resources such as insects, i.e., insect pests, and plant diseases, i.e., rice diseases.

Genetic resources of field crops such as sesame, sorghum, native pod plants, soybean, paper mulberry, peanut, rami, castor oil, cassava, sweet sorghum, sugarcane, wild sugarcane, mungbean, corn for human consumption, native plants of Isan, and plants in the genus *Dioscorea* (yam).

Horticultural PGR such as: important fruit trees - durian, longan, longon, langsat, mangosteen, orange, pomelo, and rambutan; ornamental flowers which have potential for cultivation - torch ginger, *Curcuma*, orchids; native fruits from on-farm genetic resources; and *in situ* genetic resources - tropical fruits, native fruits, subtropical fruits and temperate fruits.

Industrial horticulture from on-farm genetic resources and *in situ* genetic resources: coconut, pineapple. Ornamental flowers from on-farm genetic resources and *in situ* genetic resources: fragrant and ornamental flowers. Vegetables from on-farm genetic resources and *in situ* genetic resources: native vegetables, parkia (*Parkia speciosa*), niang (*Archidendron jiringa*).

- Conservation of genetic resources of plants, microorganisms, insects, mites and animal pests, and natural enemies by the HRI, BRDO (Division of Plant Conservation), Office of Agricultural Regulation, Office of Plant Protection Research, Agricultural Production Science Research and Development Office, Office of Post harvest, FCRI, RRI, 22 service centers, 10 RRCs, 8 FCRC, 9 HRC, 4 Rubber Research Centers, 8 Offices of Research and Development of Agriculture. The project consists of 2 activities as follows:

Activity 1: Study of the conservation of genetic resources of plants, microorganisms, insects, mite and animal pest, and natural enemies in genebanks by researching the technology for storing genetic resources in genebanks, in: horticulture - vegetable seeds; herbal plants/rare plants - seed of fa thalai chon (*Andrographis paniculata*); field crops - seed of field crops; rice - rice seed; and microorganisms, insect, mite and animal pests, and natural enemies - beneficial microorganisms for agriculture, plant disease microorganisms, microorganisms used to produce bioextracts, mushroom spores. Technology for storage of genetic resources in sterile conditions and cryopreservation is being studied for: horticulture - rambutan, papaya, banana, orange, coconut, commercial orchids, potato; herbal plants/rare plants - som khaek (*Garcinia atroviridis*. *G. cambogia*); orchids in the chang group; endangered wild orchids; wild orchids in the uang group, uang pak nok kaeo, uang ngern luang, lin kra bue (*Exoecaria cochinchinensis* var. *cochinchinensis*), *Ficus callosa*, chang saraphi (*Acampe rigida*), ma wing (*Dorites pulcherrima*), fa mui (*Vanda coerulea*); rice - wild rice.

Activity 2: Studying, surveying, collecting and *ex situ* conservation in field collections, and *in situ* conservation by conducting research on the identification of genetic characteristics using morphology in *ex situ* and *in situ* plants for: horticulture such as important fruit trees - durian, longan, mango, longon, langsat, mangosteen, orange, pomelo and rambutan; ornamental flowers that have potential for cultivation - torch ginger, kra chiao, orchids; fruit trees - exotic fruit trees, tropical fruit, native fruit, good varieties of fruit, subtropical fruit and temperate fruit; industrial horticulture - cocoa, Robusta coffee, cashew nut, coconut, tea, pineapple, Arabica coffee, macadamia, and Chinese chestnut; ornamental flowers - gerbera, jasmine, Anthurium, Chrysanthemum, banksia, hippeastrum, ornamental water lilies and fragrant flowers; vegetables - native vegetables, northern native vegetables, bamboo shoots,

asparagus, eggplant, large chili (*Capsicum annuum* var. *annuum*), small chili (*Capsicum frutescens* var. *frutescens*), kui chi Chinese chives (*Allium tuberosum*), morning glory, taro, sweet potato, wai orchids, vegetable.

Herbal plants/rare plants: herbal plants, herbal plants in the ginger family, yam family plants, rare plants and endangered plants, wild orchids.

Field crops: sesame, sorghum, peanut, rami, sugarcane, wild sugarcane, sweet sorghum, soybean, paper mulberry, cassava, mungbean, corn for human consumption, castor oil, native tua pods, cotton, corn for animal feed. Variation in flowering in *ex situ* genetic resources of cassava is being studied.

Wild rice, rubber: study on the identification of genetic characteristics using morphological characteristics of cultivars.

Native plants and new plants both *ex situ* and *in situ* (pomelo, durian, litchi, longan, papaya, cassava, *Curcuma* species) for conservation.

Activity 3: Storage of plant specimens of plant diseases, insects, mites, animal pests, and natural enemies in museums by collection, sample preparation, identification, analysis, classification of specimens in museums including curating specimens, cleaning, fixing and setting up databases, reporting results and then preparing documents for distribution about plants, weeds, plant diseases, and insects.

2.2 Seed supply system and the role of markets

The national seed industry programme of the government and private sectors is considered a model of outstanding development even though the industry has a complex infrastructure. The integration of different tasks requires the active participation and co-operation of many persons and agencies. The seed policy of the Thai Government is to promote the production and distribution of high-quality seed. The government is encouraging the private sector to play a greater role in seed production and will offer incentives to invest in the seed business. Simultaneously, in order to avoid competition, the government will not produce the same types of seed as those already being produced by the private sector. The government agencies involved in the seed industry are DOA and DOAE.

The Bureau of Seed Multiplication, under DOAE, is responsible for the development of technology to improve the seed production and management system It also maps out seed production plans, produces seed of major economic crops, promotes the use of improved seed varieties and technology, and encourages the private sector and farmers' institutions to produce high-quality seed.

There are 23 Seed Centers located in every region of Thailand. They are locally operated agencies for seed production and distribution under the Bureau of Seed Multiplication. Each seed center originally had a processing capacity of 1,500-2,000 metric tons (mt) per year. However, due to increasing demand, seed production capacity is being increased in order to

meet demand (Table 16). Seed is primarily distributed to farmers through various DOAE crop promotion projects and the natural disaster relief programme. Surplus seed is sold through agricultural co-operatives to farmers' groups and individual farmers.

Table 16 Seed production plan, DOAE, 1999-2003

Crop	1999	2000	2001	2002	2003
Rice	44,000	47,500	55,900	70,000	70,000
Soybeans	10,000	10,400	10,400	11,600	14,000
Mung beans	5,000	5,000	5,000	5,400	5,000
Peanuts	2,000	2,000	2,000	2,300	2,000
Other	1,000	1,000	1,000	1,000	1,000
Total	62,000	65,900	75,900	90,300	92,000

The private seed company has concentrated on the development of corn varieties and hybrids for all vegetables. Thailand is promoting all seed activities. In this regard, international seed companies have been able to use their overseas technical and financial strength to start breeding activities in the country. More and more, the private sector is playing an important role in variety development in the country. Early breeding work of the international companies was undertaken with hybrid tomatoes, hybrid corn, hybrid watermelons, and hybrid vegetables.

Competition between seed companies in Thailand is quite high, which encourages the production of good quality seeds. More than 20 seed companies in Thailand are active in introducing, improving, producing and breeding seeds. During the past 20 years, the vegetable seed industry in Thailand has also made considerable progress with the development of high-performing hybrids of many vegetables such as cucumbers, pumpkins, bitter gourds, tomatoes, eggplants, chilies, and watermelons. This is highlighted by the fact that the value of seed production for export increased from US$ 24.9 million in 1998 to US$ 31.3 million in 2002. At present, the use of low-value commodity seeds has been moving towards high-value varieties and hybrids.

The seed industry is traditionally associated with the private sector. There are signs of increasing professionalism and opportunities in this sector. Companies through controlled contract production and good quality control are producing more seed locally. Thai seed firms are trying new products and entering into seed multiplication contracts with foreign seed firms to produce seed for re-export.

Among the 80 species of crops used in Thai cooking, about 40 to 45 species are widely used. They include field crops that are staple foods and many types of vegetables. The other species are seasonal native vegetables. Field crops are mainly grown under rain-fed conditions whereas vegetables are produced year-round using an irrigation system. Surplus production occurs from December to February due to favourable climatic conditions. The amount of

domestic seed used can be estimated from the planted acreage from 1999 to 2002. Future seed use trends can be projected based on three factors:

- The growth of the population, migration and tourism
- Increasing interest in using healthy food
- Rising exports of fresh and processed food products

Recently, yield per acreage slightly increased due to the input of new technology but there is still a large gap in both quantity and quality of seed yields.

The marketing of field crops and vegetable seeds are different in terms of seed distribution due to the nature of the crops. With regard to field crops, companies sell seed directly to merchants who are also retailers of seeds on consignment just before the growing season and who will take seed back after the growing season. Moreover, because of special conditions such as natural disasters or adverse climatic conditions that damage farm crops, the government may need seed from the private sector for relief programmes.

Although a regulatory framework is in place in the country, there are some major constraints to making seed of new varieties available in the market as follows:

- Inadequate seed distribution systems.
- Varieties poorly adapted to local conditions.
- Insufficient availability of basic/foundation seed.
- Insufficient availability of commercial seed
- Availability and cost of required production inputs.
- Insufficient availability of disease-free planting material.
- Distance to seed supplier.
- Seed price too high as compared to commodity price.
- Inadequate seed production systems.

2.3 Crop improvement programmes and food security

Plant breeding and research programmes in Thailand are conducted by many agricultural institutions, universities and seed companies.

Government sector:

The Government of Thailand is primarily responsible for research and development of rice varieties that are appropriate for growing in the various agro-climatic regions of the country, followed by field crop research as suggested by the National Economic and Social Development Board (NESDB).

Germplasm and maintenance are undertaken to support varietal development with strong breeding programmes into which research funds are channeled. Government seed breeding activities are carried out at various research stations of DOA. Consideration is given to developing varieties for specific cropping conditions and include determining distinct 'markers' in varieties to facilitate genetic purity in seed production. Varietals development, both of open pollinated and Fl hybrids, in the government seed sector is mainly aimied for local use. Breeder seeds, the basis of the seed industry, are developed by the breeders in active breeding programmes. After that, breeder seeds are multiplied to establish foundation seeds. Varietals testing and recommendations are provided in co-operation with the Seed Division under DOAE.

The Seed Division, DOAE is involved in government seed supply. Foundation seed of outstanding varieties is managed in order to produce "certified" or "extension" seeds through the process of producing/handling stock seed including storage.

Until 2003, various centers and research stations of the RRI of DOA were developing as many as 50 superior varieties of rice. During that time, the FCRI also released 40 varieties for 11 field crops including cassava, sugarcane, corn for human consumption, corn for animal feed, soybeans, peanuts, mung beans, sunflowers, cotton, sesame and jute. The HRI, meanwhile, developed 11 varieties of 9 types of vegetables and 17 varieties of 9 types of fruit crops.

Agricultural universities also play an important role in varietal improvement, research and development. The leading and most widely known university in this field is Kasetsart University through its National Corn and Sorghum Research Center, which has released:

- Field corn varieties of the Suwan series - 4 composites and 6 hybrids
- Sweet corn - 2 composites and 3 hybrids
- Baby corn - 1 composite and 2 hybrids
- Five sorghum varieties
- One pearl millet variety
- Three sesame varieties
- One safflower variety
- Three legume varieties.

A number of crops, vegetables, tubers, fruit crops, industrial horticultural plants, ornamental plants, herbs, guava, lime, papaya, pommelo, dragon fruit, rambutan, mango, santol, tamarind, jack fruit, durian, rice, barley, wheat, corn, sorghum, mungbean, groundnut, bambara groundnut, soybean, sesame, castor bean, sugarcane, mulberry, cocoa, oil palm, coconut, cashew nut, para rubber, hemp, cotton, paper mulberry, parsnip, taro, potato, sweet potato,

cassava, *Curcuma*, banana, Chinese kale, garden pea, Chinese convolvulus, pineapple, chili, bamboo, and neem have been registered as RPV according to the Plant Varieties Act 1975 for the purpose of quality and recommended varieties. In this regard, 100 crop varieties have been released so far . The quality of such seed is based on ISTA rules and based on nationally defined standards.

3. Major constraints to the utilization of conserved PGR

Although a number of activities have been carried out to encourge the sustainable utilization and conservation of PGR, some areas, such as activities to transfer of appropriate technologies that are necessary for promoting exchange of PGRFA, should be emphasized. Enhancment of the exchange of PGR both at the regional and international level in order to promote the maintenance and sustainable use of genetic resources is crucial.

However, some obstacles still exist, such as the lack of trained personnel, the need for a core collection is not recognized, the limited number of accessions available, inadequate available information on accessions, and methodology is too complex. Some obstacles limited characterization and evaluation as follows:

- Lack of budget to maintain diversity of PGR.
- Lack of trained personnel and appropriate technologies for multiplication, characterization, and evaluation of PGR.
- Lack of human resource development through degree and non-degree training programme to be responsible personnel for laboratory handling and preservation of threatened plant species.
- Lack of facilities for the preservation of preserved plants.
- Lack of scientist exchange programme which are needed for contact with experts as well as for exchange of methodologies.
- Identify the leading laboratories for specific plant species.
- To establish a database, adequate computer equipment and programmes are needed. In addition, there is not enough GPS for survey of source areas and collection locations, which has affected plans for recording the distributions of PGR. In addition, there are more requests for recording equipment to be used while surveying and collecting.

4. Assessment of needs to improve utilization

- Set up a systematic database for the PGR system
- Establish field genebanks at the national level as collections of plant genetic material and for study.
- Support and campaign for conservation of plant genetic resource *in situ* conservation.

- Conserve plant genetic resources using high technology, e.g., tissue culture and cryopreservation.
- Use plant genetic resources for plant improvement by normal methods and by biotechnology.
- Study economic values for nutrition, pharmacology, etc.
- Efficient processing of applications for plant certification, for recommended plant varieties, for registration and for conservation for farmers and interested people.
- Establish networks between organizations and researchers both local and overseas. Develop personnel by informal training and by formal training with certification for the persons responsible for laboratory management and conservation of endangered genetic resources.
- Provide equipment and material for plant conservation.
- Exchange researchers in order to meet with specialists and exchange technology.
- Provide funds for conservation activities from government and international support.
- Identify the leading laboratories for different plant types.

Chapter 5

The State of National Programmes, Training Needs, and Legislation

1. National programmes for PGR

Having recognized that national programmes on PGR are the key to realizing national, regional, and global goals in the conservation and use of genetic resources over the past 10 years, some agencies have contributed to the development of strong national programmes by working directly with national partners and through networks. Since 1996, a number of national entities functioning as a governance structure responsible for coordinating and/or facilitating PGRFA activities in the country have been established (Annex 14). Moreover, there are a few organization and fund-supported researches that have contributed to the conservation and sustainable use of biological diversity. Major institutions are The Institute for the Promotion of Teaching Science and Technology (IPST), the National Science and Technology Development Agency (NSTDA), the National Research Council of Thailand (NRCT), the National Science Museum (NSM), the Community Organizations Development Institute (CODI), the Agricultural Research and Development Agency (ARDA), the Health Systems Research Institute (HSRI), and the Thailand Research Fund (TRF). In contrast, the number of technical experts and legal experts working in the national programme are decreasing while the number of managerial/policy experts is stable.

Among the above organizations and funds, there is a particular programme called the Biodiversity Research and Training Programme (BRT). The fund was originally co-supported by TRF and the National Center for Genetic Engineering and Biotechnology (BIOTEC) in 1997. Programme funding is intended to aid Thai researchers and institutions; foreign researchers are also encouraged to submit project proposals satisfying certain criteria, which apply to all successful proposals. In this regard, researchers must work closely with local governmental, non-governmental, educational institutions or organizations, principal investigators must be involved in the project in meaningful ways, and the project must provide benefits to Thailand such as technical training, institutional strengthening, improved research capacity, shared useful data, and increased public awareness.

BRT does not only provide a crucial part of BIOTEC moving toward the “National Biotechnology Policy Framework (2003-2011)”, but also provides the key mechanism for the nation in training biological researchers and providing opportunities for youth to be interested in biology and its implications. Outputs from 8 years of BRT (up to 2004) can be listed as 527 published papers (of which 64 were international papers), 291 newly discovered species, 301 post graduates, 49 technical books and reports, and uncountable training and field educational trips for youth. Most importantly, BRT focuses its working pattern to be closely linked to local communities, and not to key researchers who only visit the sites. Therefore, research design is automatically integrated with local wisdom, which is then brought back to youth groups and school curricula.

Moreover, in 1997, the government cabinet issued a budget for a policy in biodiversity conservation and sustainable utilization from 1998 to 2002. According to this grant, the Northeastern Thailand Biodiversity Center (NTBC) was established in 1998 at Mahasarakham University. Table 17 showa current projects regarding PGR in NTBC.

Table 17 PGR Project of NTBC

Project Title	Time Period
Training Personnel for Taxonomic Database Management	1998-2002
Study of Flora in Northeastern Thailand	1998-2002
Scholarship for MSc. and Ph.D. in Bioscience and Taxonomy	1998-2002
MSc. Curricula in Biodiversity and Population Genetics	1998-2002
Workshop and Training of Personnel for Biodiversity	1998-2002
Local Community Training in Conservation and sustainable Utilization of Biodiversity Resources	1998-2002
Developing Research in Utilizing Medicinal Plants for Commercial Use by Biotechnology	1998-2002
Developing Research in Utilizing Medicinal Plants for Commercial Use, esp. Vegetables in Northeastern Thailand	1998-2002
Fund Raising and Campaign / Environmental Research and Development in Northeastern of Thailand	1998-2002

Furthermore, The Thai government has set up two independent funding agencies as part of the long-term development of science and technology: the NSTDA established in 1991, and the TRF founded in 1992. The TRF provides support for basic and applied research activities in various disciplines including science and technology, arts, humanities, sociology and education. NSTDA is organized into divisions that support research and training in a few broad priority areas: National Metal and Materials Technology Center (MTEC), National Electronics and Computer Technology Center (NECTEC), and the National Center for Genetic Engineering and Biotechnology (BIOTEC). BIOTEC has given broad support to projects in DNA technology, crop development and improvement, fermentation technology, and bioprospecting of natural products from wild species.

It has become clear in the endeavors that lack of knowledge of taxonomy, distribution, and ecology of native species will continue to be a major impediment to the discovery and development of useful plants and microorganisms, particularly those living in tropical forests. Realizing these problems, BIOTEC, in collaboration with TRF, has established a special programme for BRT, which is expected to become a major part of a new National Center for Biodiversity to be established soon. The major objective of the BRT programme is to promote research on the conservation and sustainable use of biological resources. This programme has made available substantially increased funding for basic and applied research in disciplines relating to biodiversity, encompassing its various subsystems: genes and genetic systems, species and ecological diversity, and ecosystems.

There is no direct legal framework for PGR strategies, plans and programmes, but there are over all strategies namely, the National Policy, Strategies and Action Plan for the Conservation and Sustainable Use of Biodiversity, 1998–2003, and 2003–2007 which consist of seven strategies (Box 2). Several activities have been set up to implement the Convention on Biological Diversity (CBD).

Box 2 National Policy, Strategies, and Action Plan for the Conservation and Sustainable Use of Biodiversity

Strategy 1:	Enhance knowledge, understanding, and public awareness of the importance and value of biodiversity.
Strategy 2:	Build capacity and expertise of institutions, and their staff in biodiversity conservation.
Strategy 3:	Strengthen capacity in conservation, restoration, and protection of natural habitats, within and outside protected areas.
Strategy 4:	Ensure efficiency in conservation and sustainable use of species and genetic diversity.
Strategy 5:	Control, monitor and reduce the threats to biodiversity.
Strategy 6:	Provide incentives and encourage public participation in the conservation of biodiversity in accordance with Thai traditional and cultural practices.
Strategy 7:	Promote and develop international cooperation and collaboration in the conservation and sustainable use of biodiversity.

2. Network

Thailand has long supported the concept of networks as a means to help countries share the responsibilities and costs of genetic resources activities. Some agencies are involved in regional and crop networks, a number of them currently provide or house the secretariats of certain networks. In response to this activity, DOA, the Office of Natural Resources and Environmental Policy and Planning (ONEP) and the Royal Forest Department (RFD) have been working as the coordinating institutions for the National Programme for Plant Germplasm Conservation and Utilization. Sixteen activities have been carried out in collaboration with six networks (Table 18).

Table 18 PGRFA network activities

Name of network	Network activity description
Centro Internacional de Agricultura Tropical	Cassava Breeding and Conservation
Maize Program, Centro Internacional de Mejoramiento de Mảzy Trigo	Research and Development on maize variety
Centro International de la Papa	Research Development and Planting Technology of Cassava
IPGRI	Conservation and Use of Native Tropical Fruit Species Biodiversity in Asia
IPGRI	Germplasm Evaluation, Propagation and Management of Jackfruit, Mangosteen and Pummelo in Asia
IPGRI	Regional Co-operation in South-east Asia on Plant Genetic Resources
IPGRI	Participatory Survey to Identify Production Constrains, Multipurpose Uses and Suitable Varieties Especially for Sap and Sugar Production
IPGRI	Improvement of Technology for Higher Quality and Production of Coconut Sugar and Technology Dissemination to Farmers
IPGRI	Evaluation of Coconut Germplasm Accessions for Sap and Sugar Production
IPGRI	Collecting, Characterization and Conservation of Young Tender Coconut Ecotypes
IPGRI	International Musa Testing Programme
IPGRI	IPGRI-ACIAR-TFT
IPGRI	IPGRI-UNEF-GEF
Crops Research Institute for the Semi-Arid Tropics	Minicore Project
Crops Research Institute for the Semi-Arid Tropics	Enhanced Utilization of Sorghum and Pearl Millet Grains in the Poultry Feed Industry to Improve Livelihoods of Small Scale Farmers in Asia
International Rice Research Institute (IRRI)	Rice Research
International Maize and Wheat Improvement Center (CIMMYT)	Cereal breeding

Having collaborated in networking, Thailand has gained many benefits through these PGRFA networks, for example, transfer of technology, back up safety duplication of germplasm, exchange of germplasm, exchange of technical expertise, exchange of information, and joint characterization and evaluation of germplasm Table 19 shows the publications that have contributed to the local network activities.

Table 19 Publications that have contributed to local network activities

Stakeholder	Title of publication	Name of network
BRDO	Collection, Conservation and Evaluation of Rice Genetic Resources in Lower Northern Thailand	DOA
BRDO	Collection, Rejuvenation and Evaluation of Rice Genetic Resources in The Lower Northern Thailand	DOA
Prachin Buri RRC	Characteristics of Thai Local Varieties	Biotechnology Research and Development Center, RRI
Prachin Buri RRC	Characteristics and Valuable Traits of Thai Local Varieties	DOA, RRI
FCRI	Conservation and utilization of field crops genetic resources	FCRI

On the other hand, the elements for improving communication skills and packages to the public show limited achievement. However, as there are many means for outreach activities, the question becomes how and what message are to be delivered to wider groups.

To promote Plant Genetic Diversity (PGD) related issues through the press, various media and public relations and communications networks at national level exist. The most effective media in Thai society is television. Due to limited budgets and the need for expensive investment in television broadcasting, only a few government authorities can use this medium ONEP, as a Clearing House Mechanism (CHM) plans to improve its investment in this mass media in the future.

Besides research and educational organizations, NGOs also play a big role in this issue. These NGOs are for example: WWF-Thailand, Yadfon Association, Sueb Nakasathein Foundation, and Green World Foundation.

In addition, the government of Thailand has always supported to promote PGD in the following ways:

- Direct financial support through membership dues
- Travel costs to attend meetings
- Publishing costs
- Technical expertise in joint activities

- Organization and hosting of network meetings
- Institutional infrastructure to participate in joint activities
- Information management support for the National Coordinator, which is included in the text of the new law is very useful from the point of view of network integrity.
- All network participants were involved during the preparatory phase of the law and the relevant executing edict.
- The final acceptance of the law on PGRFA conservation and utilization resulted from the effort and support of coordinated network activities.

3. Education and training

Regarding the activity in this area, a strategy exists but it is not being adequately implemented in Thailand. Moreover, training and educational opportunities in PGRFA conservation and utilization are rare and inadequate in the country. Some training at the university level exists, but they are not sufficient to meet our needs. Furthermore, some short course training exists in the region, but they are not sufficient to meet our needs.

Most systematic educational and training programmes are institutionalized into academic curricula. Thailand has 69 public universities throughout the country. Well known niversities are Chulalongkorn, Kasetsart, Mahidol, Chiang Mai, Khon Kaen, Burapha, Prince of Songkla, Maejo, Ubonratchathani, Rajmakala (located in 9 major provinces), Rajabhat (locate in 41 provinces), Silpakorn, Ramkhamhaeng, and Sukhothaithammathirat.

Besides these academic institutions, departments also provide technical training programme for not only their personnel, but for partners and the public as well. Cooperation among universities and departments has been found to be a very useful and effective mechanism for PGR education and training.

With limited resources, ONEP has produced aseries of Thai publications on the CBD which have been provided to implementing agencies and key partners for several years. Thailand by ONEP has arranged special activities to celebrate Global Biodiversity Day every year since this was declared. These activities normally include press conferences and technical workshops. Webpages of most of institutions also include information on PGR and its provisions both in Thai and in English.

Knowledge and expertise shared among professionals and practitioners. The exchange among technocrats and researchers is quite good. However, there is a crucial need to design well and invest more on tools and best practices in order to communicate with practitioners, particularly with protected area managers, farmers, community leaders, and organizations.

The Royal Thai Government has encouraged students to exchange experiences and information through an Internet website called School Net. Managed by the NECTEC. School Net, this was the first online educational resource in Asia, and was launched in Thailand in 1995 to support human resource development. The project had provided Internet

access to 2,500 secondary schools across the country by 1999, and aims to cover an additional 5,000 primary and vocational schools by 2000. The project has received strong support from private companies and public enterprises. There are currently more than 1,300 schools registered as members of the network.

However, training and educational opportunities are still rare and inadequate in the country**.** A clear national policy on this issue to strengthen this area of activity should be established.

Needs and priorities for education and training to support the sustainable use, development and conservation of PGR both in the development of a strategy and identification of opportunities for education and training outside the country, within or outside the region in the following fields:

- Surveying and inventorying of PGRFA
- *In situ* conservation
- *Ex situ* conservation
- Agro biodiversity markets and chains
- Participatory approaches to genetic resource management
- Genebank management
- Participatory crop improvement
- Biotechnology in conservation and crop improvement
- Policies at the institutional level in the fields of biotechnology, plant breeding and conservation
- International genetic resource policies
- Systems approach towards institutional implications
- Genetic resource access mechanisms and material transfer agreements
- Intellectual property rights, plant variety protection and farmers' rights
- Design of institutional policies concerning inbound and outbound intellectual property
- Genetic resources enhancing agro biodiversity use, markets and chains
- Economic perspectives of enhanced agro biodiversity use
- Market trends and sector analysis
- Supply chain concepts and chain integration
- Analysis of farm performance for under-utilized crops
- Marketing concepts for niche markets
- Business plan development on the facilitation of chain development in a selected chain

- Variety characteristics and sources of germplasm
- Designing participatory variety selection and plant breeding programmes
- Genotype x Environment interaction
- Up scaling participatory crop improvement

Main obstacles to providing required education are:

- Trained personnel are still lacking for train the trainer programmes.
- Human resources to provide quality training in the country are still pauce.
- Staff have a high rate of turnover.
- It is not a national priority.

4. National legislation

Thailand pays special attention to the legal aspects of PGR. Many laws concerned with forest, wildlife, plants, and genetic materials have been passed, but their execution and enforcement can be difficult. Responsibility for biodiversity is spread over a number of government institutions. A number of laws and regulations protects Thailand's PGR. Some of the important ones are as follows:

- The Constitution of the Kingdom of Thailand 1997
- The National Park Act 1961
- The National Forest Reserve Act 1964
- The Plant Quarantine Act of 1964 and Plant Quarantine Act (second issue) 1994
- The Seed Act 1975 and Seed Act (second issue) 1992
- The Importing and Exporting of Goods Act 1979
- The Enhancement and Conservation of National Environmental Quality Act 1992
- The Plant Varieties Protection Act 1999
- The Protection and Promotion of Traditional Thai Medicinal Intelligence Act 1999
- The Community Forests Bill (CFB)

4.1 The Constitution of the Kingdom of Thailand 1997

Article 56 stipulates the right of all individuals to participate with the government and community in helping to maintain biodiversity as well as to enjoy benefits from the utilization of natural resources and biodiversity. Article 79 of the Constitution stipulates that the government should enhance and support public participation in preserving, maintaining and utilizing the balance between natural resources and biodiversity.

4.2 The National Park Act 1961

The Act stipulates that natural parks should be established. The objective is to initiate protection, control, and overseeing of natural ecosystems and natural habitats of plants and animals. Collection or transport of wood and natural resources out of any park's boundaries are prohibited. Other prohibitions include transporting and damaging animals, collesting and transporting orchids, flowers, leaves, and fruits. Profit–oriented activities are prohibited in the parks.

4.3 The National Forest Reserve Act 1964

It prohibits unauthorized processing of wood and collecting of wood products in national preserved forests. In addition, the Act authorizes the MOAC to issue ministerial notification, as it sees appropriate, to establish national preserved forests in order to maintain the state of the forest, wood products, and other natural resources.

4.4 The Plant Quarantine Act 1964 and Plant Quarantine Act (second issue) 1994

It identifies prohibited plants, pests and vectors, and Genetically Modified Organisms (GMOs) and plants that are the result of biological technology as prohibited materials. Export and/or import of prohibited items needs approval by DOA and are approved only for research and experiment purposes.

4.5 The Seed Act 1975 and Seed Act (second issue) 1992

This law describes seed labeling requirements and minimum allowable germination requirements for 20 species of seed.

4.6 The Import and Export of Goods Act 1979

The Act controls the import and export of certain goods listed in the Royal Decree of 1975 (Issue no. 39) and 11 notifications on the export of goods of the Ministry of Commerce released since 1974. Such notifications list names of wild animals, wild animal carcasses, aquarium fish, and other aquatic animals that are controlled and requir export permits to be taken out of Thailand.

4.7 The Enhancement and Conservation of National Environmental Quality Act 1992

It stipulates the authority of the Ministry of Natural Resources and Environment (MONRE) to issue ministerial regulations to protect areas that have unique natural ecosystems or are vulnerable to destruction. These areas should be protected using reasonable measures that are in harmony with their unique character.

4.8 The Plant Varieties Protection Act 1999

The Act provides protection of new plant species, endemic plant species, and local and wild plant species. The Act specifies that permission is needed and benefit sharing should be clarified if the stored or collected plant species or their parts are used for species improvement study, experiment and research for commercial purposes.

4.9 The Protection and Promotion of Traditional Thai Medicinal Intelligence Act 1999

It protects formulas of traditional Thai drugs and similar texts on traditional Thai medicine. Such formulas and text documents can be of three categories – national, general, or individual/personal. National and individual formulas and documents can be registered and intellectual property rights applied to them Such intellectual property rights should be valid for the lifetime of the bearer of the registration and for another 50 years from the time of the registration owner's death. Patents on drugs can also be applied for under the Act.

4.10 The Community Forests Bill (CFB)

The CFB represents an important opportunity to balance desires for forest and watershed conservation areas, and the maintenance of the culture and livelihood of indigenous minority groups and local communities *in situ*. It also controls of access and benefit sharing arising from the utilization of genetic resources, which are things that seems far removed from the daily lives of communities.

5. Information system

Thailand has not yet developed an adequate national information management system to support efforts to sustainable use, develop, and conserve PGR. Each institution has its own database that is not in a standard format to facilitate data exchange. Although all of them are responsible for PGR, information systems have been designed for their own interest. For instance, the PVPD has designed database for conservation and protection purposes while the national genebank has its database for characterization and related activities. On the other hand, the private sector like Nong Nooch Tropical Botanical Garden has developed its information system as a single-user (stand-alone) database management system using the BG-Base software for *ex situ* (multi-crop) collections.

It is estimated that among only 33% of institutions are equipped with computers and provided with internet connections. Although the information system is still not a national system, there are some activities being developed in data and information management systems for PGRFA in the country (Table 20).

Table 20 Activities support the development of data and information management systems for PGRFA

Stakeholder	Name of programme/project/activity
BRDO, RRI	Conservation of rice genetic resources (exploration, collection, characterization, evaluation and database management)
FCRI	Conservation and utilization of mungbean and black gram genetic resources
FCRI	Conservation and utilization of soybean genetic resources (survey, collection, evaluation and database management)
FCRI	Conservation and utilization of sesame genetic resources (survey, collection, evaluation and database management)
FCRI	Conservation and utilization of cassava genetic resources (survey, collection, evaluation and database management)

6. Public Awareness

Public awareness is not considered an important part of the overall policy response to the PGR issue; however, responses to PGR problems are still limited. They require effective contributions from individuals, communities, businesses, and professional groups. A prerequisite for such contributions, however, is the availability of adequate and up-to-date information on the possible action to be taken as well as a clear understanding of the issues involved. On the issue of PGR and its conservation, Thailand's approach to public awareness comes in various ways. At the most fundamental level, there are government agencies that disseminate information on the issues to the public through different media including newspapers, radio, television, posters, and other means.

Campaigns are launched extensively on appropriate occasions and public participation is solicited to the greatest extent possible. A basic knowledge of PGR issues is emphasized in the educational system Public awareness on PGR issues such as *in situ* conservation is not raised through systematic dissemination of information. In addition, limited public awareness is enhanced through direct participation in PGR conservation activities.

Since the early 1990s, Thailand has strongly supported the role of NGOs in PGR management. Workshops and on-the-job training have been organized by NGOs in many areas. Increasing concern over the rapid deterioration of PGR in recent years has also induced the private sector to actively participate in PGR conservation activities. Thus, public awareness and actions to promote PGR may become an interactive process in the future.

Over the past decade, NGOs in Thailand have actively participated in rural development and resource conservation. Interaction among NGOs, between NGOs and the media, between NGOs and academic institutions, and between NGOs and government agencies have increased substantially in recent years. NGOs now play an important role in building local capacity in PGR management and in enhancing PGR awareness among local communities. On the other hand, workshops and seminars organized to raise public awareness and update the issues Are still limited. However, these activities should continue and be intensified in the future.

7. Major constrains on national programme, development, training and legislation

- Lack of financial resources
- Networks are poorly managed and ineffective.
- Networking is not a national priority.
- Appropriate national partners/stakeholders are not identified
- National policy on information system and responsible body are not clear.
- Weakness of the national networking system
- Human resources within the country are limited especially in the field of sustainable PGR production.
- The conservation and use of PGR has received low priority by researchers.
- Breeding programmes have not been conducted for all major crop species.

8. Major needs for national programmes, development, training and legislation

Although a number of activities regarding PGRFA exist in national programmes, they have not covered all elements needed. Therefore, the main challenges, needs, and priorities to strengthen the national programmes, development, training, and legislation over the next 10 years are as follows:

- Systematic PGD and ecology: This programme would emphasize studies, which increase knowledge about PGD, with emphasis on genetics, species, communities, and ecosystems. The projects, which would constitute this programme, include taxonomic work, surveys, and inventories of particular environments or ecosystems, and studies of the ecology, PGD, and distribution of important species.

- Monitoring of populations and ecosystems: The monitoring activities under this programme would seek to describe and to understand the dynamics of ecological systems and would examine the effects of human disturbance over time. The projects would be to monitor populations, especially the abundance and distribution of species.

- Economics, society, and indigenous knowledge related to PGD: This programme would focus on the knowledge and use of biodiversity by local residents and communities through systematic collection of folk knowledge, study of indigenous plants and the effects of human activities on the biosphere, and local wisdom of ecologically sustainable agricultural methods.

- Information coordination: This programme would recognize the opportunities created by the rapid advance in information technology and seek ways in which that can be used to enhance the capability of PGD researchers to organize and store data efficiently and make it available to others.

- Human resource development and training: This programme would support high quality training and educational activities such as improvement of graduate programmes,

research grants, and scholarships for Masters' and Doctoral studies at Thai or international universities, workshops, seminars and conferences.

- Development of technological efficiency for sustainable social and commercial uses of PGR**:** Projects under this programme would aim to identify PGR with pharmacological, agricultural, social, and industrial uses, and to develop human, scientific and technological resources for research and development of natural products. The scope of the programme would include: the increase of technological capacity to study and develop natural products in Thailand; research on sustainable uses of PGR; collection and storage of PGR with potential for scientific and commercial applications.

- Policy development and management of PGR: Projects under this programme would promote development of policies and management capacities by which PGR can be sustainable utilized. Projects would focus on analysis of social and economic incentives for managing PGR and examination of roles and values of PGR in society, the economy and the environment.

Chapter 6

The State of Regional and International Collaboration

1. Regional and sub-regional networks, international crop-specific networks and sub-regional collaboration for maintaining *ex situ* collections

Thailand has long supported the concept of networks as a means to help countries share the responsibilities and costs of genetic resources activities. Some institutions are involved in regional and crop networks, a number of them currently provide or house the secretariats of certain networks. In this regard, DOA, ONEP and RFD have been working as the coordinating institutions for the National Programme for Plant Germplasm Conservation and Utilization. Sixteen activities have been carried out in collaboration with 6 networks (Table 17, Chapter 5).

Thailand has a history of making donations to CGIAR research centers, particularly IRRI, as well as cooperation with their research projects. At the same time the International Agricultural Research Centers (IARCs) were established in Thailand, many genebanks were also established and administered by government departments or universities for research and academic purposes.

Moreover, Thailand has been actively worked with FAO on the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) for almost 30 years and was involved in the establishment of IPGRI. Expertise, understanding and mechanisms referred to the treaty were fully adopted in the process. Thailand is a regional hub of international institutions in this field. These organizations include IUCN, FAO, the Global Environment Conservation Organization (WWF), the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP), etc. Furthermore, Thailand proactively invites and welcomes international meetings.

Having collaborated in networking, Thailand has gained many benefits through PGRFA networks, for example, transfer of technology, backup safety duplication of germplasm, exchange of germplasm, exchange of technical expertise, exchange of information, and joint characterization and evaluation of germplasm

However, there are some major constraints to effective participation in regional and/or international PGRFA networks as follows:

- Lack of human resources
- Networks are poorly managed and ineffective
- Networking is not a national priority
- National policies limit the ability of Thailand to share germplasm
- Bilateral relations are found to be more beneficial than multilateral
- The benefits of participation in networks are not clear

- Suitable partners for networking have not been found
- No agreements on benefit-sharing among potential partners
- Appropriate national partners/stakeholders are not identified

In addition, the government of Thailand has always provided support in the following ways:

- Direct financial support through membership dues
- Travel costs to attend meetings
- Publishing costs
- Technical expertise in joint activities
- Organization and hosting of network meetings
- Institutional infrastructure to participate in joint activities
- Information management support for the National Coordinator, which is included in the text of the new law and is very useful from the point of view of network integrity.
- All network participants were involved during the preparatory phase of the law and the relevant executing edict.
- The final acceptance of the law on PGRFA conservation and utilization resulted from the effort and support of coordinated network activities.

2. International programmes

2.1 Research

During the past 2 decades, there have been a number of international programmes for PGRFA that have been beneficial to the country, but over the past 10 years, they have declined because of national policy to stop financial support from outside. However, some collaborative crop research programmes already exist in the country with IRRI, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), CIMMYT, Asian Vegetable Research and Development Center (AVRDC), IRRI and IPGRI where germplasm collection, evaluation and utilization are being undertaken by respective breeders. Further regional linkages would be helpful for crop improvement programmes in similar agro-ecological conditions in this region.

2.2 Needs for future international collaboration

a) Future skill needs

The skills of national programme staff need to be enhanced in the following areas:

- Germplasm regeneration and management techniques in open pollinated crops

- *In vitro* and cryopreservation techniques for PGR conservation
- Taxonomical classification and identification of crop species
- Germplasm characterization through molecular marker techniques
- Seed technology and seed physiology
- Seed health and plant quarantine

b) Future collaboration needs with international bodies related to PGRFA

- Joint collecting, evaluation, documentation, sharing and exchange of germplasm
- Domestication and introduction of new crop species among countries
- Documentation and promotional activites for under-utilized crops
- Regional germplasm repositories for duplicate conservation

c) Training needs

- MSc. and Ph.D. training at international PGRFA institutions in the region and elsewhere
- Characterization, evaluation and documentation (including evaluation for specific traits, molecular characterization, and genetic diversity analysis)
- Wide hybridization, including embryo rescue techniques to increase the scope of the use of germplasm
- Data management and software integration and bioinformatics network
- Molecular characterization; study tours for better understanding of *in situ* conservation
- Training in *in vitro* conservation, cryopreservation and DNA storage

3. International agreements

3.1 The Convention on InternationalTrade in Endangered Species of Wild Fauna and Flora (CITES)

In 1983, Thailand ratified CITES and has been effective in dealing with trade in plants within the CITES System, especially wild orchids, cycad species and tree ferns.

3.2 The Convention on Biological Diversity (CBD)

Thailand ratified the CBD on 31 October 2003. The Convention became effective on 29 January 2004, making Thailand the 188th Contracting Party. Thailand undertook a great deal of preparations for the Convention. Firstly in 1993, the National Environment Board established the National Committee on the CBD, with the Permanent Secretary of the MOAC as the Chair and ONEP serving as the secretariat.

Under the National Committee were working groups assigned to specific issues, such as the submission of a report on the state of biodiversity in Thailand and the development of policies, measures and plans concerning sustainable conservation and utilization of biodiversity, and so on. Secondly, the National Biodiversity Strategy and Action Plan (NBSAP), 1998–2003, and 2003–2007 were developed and approved by the Cabinet on 15 July 1997 and 11 June 2002, respectively. The NBSAP's detail relevant measures, projects, activities, responsible agencies and budgets in support of the implementation of the Convention.

At present the implementation of tasks related to biological diversity in Thailand is under the supervision of the National Committee on Conservation and Sustainable Use of Biodiversity. As part of the restructuring of government agencies in 2002, the MONRE was established by incorporating agencies working on the environment with those under MOAC. On 14 June 2005, the Cabinet gave approval to revise the 2000 regulation of the Office of the Prime Minister on Conservation and Sustainable Use of Biodiversity by restructuring the component of the National Committee on Conservation and Sustainable Use of Biodiversity to comply with the new structure, and assigning the Biological Diversity Division of ONEP as the secretariat of the Committee. The Cabinet resolution dated 10 August 2004 stipulated the following:

- Assigned ONEP as National Focal Point for the CBD and the Cartagena Protocol on Biosafety.
- The structure and manpower of the responsible unit will be revised so that they comply with the defined tasks and the operations are effective.
- Agreed to revise the Convention ratification mechanism by restructuring the national committees and their responsibilities, including establishing a biodiversity committee in each concerned agency to oversee and steer the implementation of CBD.

3.3 The Cartagena Protocol on Biosafety (CPB)

Thailand in considering to be a party to the CPB (2004). The decision of the Thai Government to address biosafety issues points to a need to put in place a legislative framework for the entire country. Such a framework defined how Thailand can regulate and promote modern biotechnology at a faster pace than in the past.

The MONRE was mandated by the Cabinet on 11 October 2004 to consider drafting legislation on biosafety. The Cabinet resolution serveed as a framework that resulted in a number of activities being carried out by the Ministry. The Committee on Drafting Biosafety Legislation, consisted of experts and official representatives from all involved agencies. The Drafting Committee considered and designed appropriate components of biosafety laws. A number of current laws and regulations in Thailand relating to living modified organisms were reviewed. Furthermore, gaps were identified prior to proposing the components. Obligations by the Party under the CPB were synthesized in order to identify components of the country's biosafety laws that should be included so that the Protocol can be effectively implemented for the benefit of the country.

The scope of the laws encompasses all possible activities of living modified organisms that may occur in the country. All living organisms; plants, animals and microorganisms are covered. Nevertheless, some issues are excluded in compliance with the CPB.

3.4 Trade-Related Aspects of Intellectual Property Rights (TRIPS)

The World Trade Organization (WTO)'s agreement on intellectual property, known as TRIPS, sets out minimal standards for patents and other forms of intellectual property protection in the 134 WTO member states. If countries do not provide these standards, they can be punished through trade sanctions. TRIPS Article 27.3(b) requires all countries to protect intellectual property concerned with plant varieties, the basis of food security. According to the agreement, this can be done by patent law or by an "effective *'sui generis'* system". Developing countries must implement this rule by 1 January 2000 and least developed countries by 1 January 2006. As a result, Thailand enacted The Plant Varieties Protection Act B.E. 2542 (1999) (hereafter PVP Act) as a *sui generis* Act to protect new plant varieties, local plants, and wild plants.

Chapter 7

Access to PGR and Sharing of Benefits Derived from their Use, and Farmers' Rights

1. Access to PGR

1.1 International agreements

Thailand may not yet have developed a PVP Act, had it not been for the requirement for a *sui generis* system or patent protection in TRIPS. Despite pressure from the private sector to develop a PVP law, it would be unfeasible given the lack of competent personnel in the DOA. After TRIPS however, agri-business (both multinational and Thai) and large scale plant breeders quickly jumped at the opportunity to push the DOA and the Department of Intellectual Property (DIP) to develop an Act to suit their interests. Both departments concurrently drafted an Act each. At the same time, NGOs and academics became concerned that the Draft PVP Act contained elements that would not protect farmers' rights, nor would they allow forms of protection for general domestic (e.g. Jasmine rice), local, or wild varieties (landraces). Initially elements were included for the protection of farmers' rights. However, explicit mention of these were gradually cut out of subsequent drafts.

Consequently, Thailand developed an Act that allows a standard of protection for plant breeders with elements similar to that of UPOV (International Union for the Protection of New Varieties of Plants) 1978 and 1991, rather than the higher standards of patent protection. The PVP Act B.E. 2542 (1999) (hereafter the PVP Act) has unique qualities however, as it also tries to reconcile protection of new varieties with the protection of general domestic, local and wild varieties. For local and wild varieties, there are also mechanisms for access and benefit sharing to registered varieties. In this sense, it is a true *sui generis* system designed to suit the diverse agricultural conditions of Thailand. It seems to be that Thailand's PVP system is a combination between the CBD and UPOV.

DOA, under provisions of the PVP Act 1999 and the PVP Committee Announcement on Criteria and Method for Benefit Sharing 2003, has in place the regulation to establish a process for benefit sharing of plant varieties and patents protecting Thai plants. However, the mechanisms are new and the enormous work requirements for registration of existing plant varieties means that registration is far from complete.

As for the overall regulations on accessing and sharing the benefits of utilizing PGR, ONEP as a national focal point of the CBD studied and evaluated relevant factors in 2004–2005 by looking into the present situation in Thailand and comparing it with relevant international agreements involving regulations and legislations in other countries. The legislation and mechanism for administration of biological resources by government agencies were also studied. The Office requested comments from experts and involved persons and consequently formulated a draft regulation of the committee on conservation and use of biological resources concerning guidelines and methods to provide access and to share benefits from biological

resources regulation. The objective is to set up guidelines for administration, access to and sharing of benefits from utilizing genetic resources.

The Draft ASEAN Framework Agreement on Access to Biological and Genetic Resources and Fair and Equitable Sharing of Benefits has essentially pre-empted potential problems where there may be biological resources shared across borders, and attempted to establish some regional unity on these matters. Currently there are laws relating to biodiversity and plant variety protection in a few countries but not all. This highlights the importance of inter-state cooperation in the region with regard to access to and benefit sharing for species that are found in ecosystems that straddle borders.

The Draft ASEAN Agreement basically applies conditions derived from the CBD to member states, for cooperation on matters of Prior Informed Consent (PIC) and Access and Benefit Sharing (ABS) where they have more than one national jurisdiction. It also establishes a clearing house mechanism, initially operated by the ASEAN Regional Center for Biodiversity Conservation (ARCBC) until a permanent body is designated by the ASEAN. To this end, the ARCBC shall establish and maintain a database on the status of biological and genetic resources, as well as access agreements and applications. Settlement of disputes is to be pursued through dialogue, and failing that, through a suitable arbitration process according to relevant international treaties. A common fund has also been established where benefits arising from the commercialisation of genetic resources can be distributed between provider states.

1.2 Maintainence of access to PGR

In Thailand, there is no standard for accessing material, but rather several depending upon the provider body. Government bodies where PGR are accessible include the DOA which maintains a genebank; the Insititute for Thai Traditional and Alternative Medicines (ITTAM) which maintains a herbarium of potential herbal remedies and tonics; and BIOTEC, which maintains a culture collection of primarily fungi, but also some other micro-organisms.

The DOA was the first department to establish a Material Transfer Agreement (MTA) policy, and a policy of permission to access genetic resources (similar to a PIC policy), as a result of a research project on the facilitation of MTAs in Thailand. These policies should in theory apply to *ex situ* and *in situ* genetic resources, as the department's policy operates concurrently with the PVP Act. For example if a researcher seeks to obtain a strain of rice held by either the DOA or a local strain registered by a farming community, they must approach the DOA. When the Council of State and Cabinet pass the Ministerial Regulations of the PVP Act a standard MTA will be formally established.

At the moment, those who wish to research and breed using crop germplasm held or administered by the department or under the PVP Act must gain permission as per DOA policy and sign an MTA. If something new is found as a result of the research, the researcher must provide a proportion of the profits in a benefit sharing arrangement as stipulated by a contract also to be established by the Ministerial Regulations of the PVP Act.

The Department of Public Health (DPH) has adopted a similar policy and is also waiting on Ministerial Regulations to be passed in relation to the Act on Protection and Promotion of Thai Traditional Medicinal Intelligence. Thus, access to herbs is in theory subject to a similar process of contract and/or MTA. It is less clear under the Act how facilitation of benefit sharing will be made upon commercialisation of a product.

BIOTEC similarly has an MTA policy for academic use only of their microbial cultures. If research is successful then the team is required to come back to seek a further contract securing a benefit sharing arrangement prior to commercialization.

It is not clear to what extent local communities or farmers who act as custodians of such resources (and associated knowledge) will be consulted and provided with adequate PIC as part of these policies. It is clear that the government bodies want to control access from researchers through some sort of access permission requirement or an MTA. However it is not clear whether this transfers down to 'original' holders of PGR and associated Traditional Knowledge (TK).

2. Fair and equitable sharing of the benefits of the use of PGR

Thailand has adopted the concept of ABS in two important bioprospecting laws, i.e. the PVP Act 1999 and the Act on Protection and Promotion of Traditional Thai Medicinal Intelligence Law 1999. Article 52 of the Thai PVP Act and Article 19 of the Protection and Promotion of Traditional Thai Medicinal Intelligence Law expressly recognize benefit sharing.

The PVP Act 1999 stipulates the protection of new plant varieties, and local and wild plants. DOA has set up a ministerial regulation concerning access to and utilization of such species. The money earned is deposited in the plant protection fund, which is intended to help and support activities related to the conservation, research and development of plant species. It is also shared with communities that conserve such plant species. The Department is developing guidelines, methods and conditions concerning application for permits, collecting/gathering general native or forest plant species, and the agreement concerning benefit–sharing. In addition, the Department is formulating guidelines and methods for community registration and registration of special native flora, including establishing a national mechanism for exchanging data in order to enhance sustainable conservation and use of PGRFA.

3. Obstacles to accessing PGR

- National policies limit the ability to share germplasm
- Bilateral relations are more beneficial than multilateral.
- The benefits of participation in networks are not clear.
- Suitable partners for networking have not been found
- There are no agreements on benefit sharing among potential partners.

4. Implementation of farmers' rights

Thailand is a continent of farmers. After decades of economic development and social change, farmers remain the largest employment group in the country and they are custodians of a large part of Thailand's PGR. The roles and rights of farmers, however, have often been neglected by governments and donors; farmers usually have little or no involvement in the formulation of policies and the management of the development programmes which affect their livelihoods.

Recent developments in Thailand's legislation aim at the recognition of traditional knowledge and the rights of local communities. The PVP Act has combined rights of plant breeders to their newly developed varieties with the protection of native varieties that have been conserved and developed by farmers and local communities.

In Thailand, communities have had their own rights in administrating and managing their local natural resources ever since Thailand was established as a nation more than 400 years ago. Although the Thai government made some efforts to centralize the authority in natural resource administration, in practice the government could manage only a few kinds of natural resources such as forests and minerals. The central authorities still allowed communities to have their own freedom in the management of water resources and farming. The government did not interfere with a communities' traditions, culture, and ways of living. The main reason may have been that existing natural resources and culture did not have economic value in the government's view.

The CFB gave the rights in National Resources Management (NRM) back to communities. This includes the management of forests, wild products, minerals and genetic resources. Although is the bill has not yet been enacted, the debate during the process of drafting and legislation educated Thai society on the role of local communities in NRM
The prominent progress in community rights in Thailand can also be noticed in the country's new 1997 constitution. In the constitution, there are three acts such as the CFB which state the principles of community rights. Particularly in Act 57 are community rights for the management of biological resources are clearly manifested. This statement in the constitution is the principle foundation and offers crucial tools for the development of laws on the rights of biological resources and indigenous knowledge in the future.

The PVP Act protects breeders' rights on new varieties and farmers' rights on traditional varieties. The main principles of the Act regarding farmers' rights are as follows:

- Rights on plant varieties grown only in particular communities will be enforced only for those communities. The rights for commercial benefits from the varieties will belong to the particular communities for the duration of protection which ranges from 15 to 25 years. This rule does not apply if these plant varieties are employed for public or non-profit purposes.
- Rights of farmers to use protected new plant varieties from propagating materials made by themselves.
- Rights to be members of the PVP committee.

Chapter 8

The Contribution of PGRFA Management to Food Security and Sustainable Development

1. Contribution to agricultural sustainability

The development of agricultural technology has been gradually increasing, while the proportion of farmers has decreased fromupwards 80% to about 60% of the total population. Over the past fifty years, the focus of agricultural research and development was to maximize crop yields, coupled with the increase in product specialization. Although yields have increased substantially, contributing to raising total production, farmers and the environment had to pay the price for keeping up with this development. During the past two decades, many farmers have chosen farming practices that are more environmentally sound and can potentially contribute to the long-term sustainability of agriculture. There is no doubt that agriculture has been a key driving force for the Thai economy over all time.

2 Contribution to food security

The country is a global leader in the production and export of a number of agricultural commodities, and its agribusiness sector includes one of the world's largest multinational corporations. It also has a relatively open culture, which has allowed new ideas and peoples to be absorbed at various times, while maintaining national and religious identity. The country leads the world in the export of rice, rubber, canned pineapple, and orchids. It leads the Asian region in exporting several other commodities, and can feed more than four times its own population. Thailand is the fifth largest food producing country of the world; it is a net food exporting country and currently ranks sixteenth among the global food and agricultural exporting countries. Agriculture now accounts for 10 % of the gross domestic product.

3. Contribution to economic development

Part of the explanation for rapid economic growth lies with national policies, and in particular to the liberal stance that over time has tended to create a more open trading economy. The commitments made under the Uruguay Round of the General Agreement on Tariff and Trade (GATT) and the ASEAN Free Trade Area (AFTA) accord requires continued trade liberalization. As one of the world's major food exporters, the country was an active participant in the Uruguay Round negotiations on agriculture. It had two main objectives. First, it aimed to strengthen the rules governing international trade so that its trade interests were not subdued by more powerful trading nations. It consequently sought an effective trade dispute settlement mechanism as an integral part of this system Second, it urged restraints on export subsidies by others, notably the European Unions (EU) and the United States (US), which favoured their own exports. The country was also keen to ensure that domestic policies of these major traders, which were responsible for most distortions in world markets (e.g. the Common Agricultural Policy of the EU and the Farm Act of the US, were brought under international discipline.

4. Contribution to poverty alleviation

Poverty problems in the country have long been accumulating with the causes deeply rooted in the lack of access to arable land, unstable and falling prices of agricultural products, and the high costs of farm inputs, including the availability of modern equipment. The MOAC is a core agency in implementing agricultural development strategy. The implementation plan of 2005-2008 vigorously focuses on farmers as the center of development, and aims to increase the GDP to US$ 22.5 billion. Farmers are expected to earn an average net income of US$ 1,000 per household annually. To achieve this target, implementation would be driven by strategies as follows:

4.1 Eradication of poverty

The government would provide land to the landless and foster occupational development and skill training to needy farmers so that they could acquire better knowledge of farming techniques. This would provide an exceptional starting point for the development of an integrated, sustainable agriculture at the provincial level. Proper management mechanisms for farm production and processing, as well as the development of marketing channels, distribution networks, product brands and development of sophisticated logistic systems are all needed to support modern-day agriculture.

4.2 Restructuring of the agriculture sector

The composition of product mix has to be adjusted. Some commodities with potential to export can increase in supply, while others may have difficulties in competing against those of other countries. Products with low competitive advantages have to be phased out.

4.3 Natural resource management

The conservation and use of natural resources must be maintained in balance. Water resources need to be managed more efficiently to avoid frequent recurrence of floods and droughts.

4.4 Foreign affairs and international economics

Efforts must be made toward trade liberalization, particularly in agriculture. Subsidies and other trade distortions should be abolished, or at least kept at minimum levels. Agricultural diversification can help reduce dependence on a few export commodities.

4.5 Increase in government administrative efficiency

The government intends to create effective management with accountability and transparency. New management styles have been introduced into administration in parallel with efforts to create corporate good governance among government agencies throughout the bureaucracy.

5. Needs and priorities to improve the contribution of PGR

Although a number of activities have been carried out in the country to increase the contribution of PGR in terms of economic, social, culture, and ecological values, efforts by PGR related institutions have yet to successfully yield beneficial results since these institutions have not been sufficiently supported either financially or institutionally. At present, there are less than 30 taxonomists in Thailand even though taxonomic researches are an extremely crucial element in better understanding PGD. The research has not been carried out under initiative of institutions but rather by individual interests, which clearly indicates shameful insufficient and unorganized support for genetic diversity research in Thailand. There is also a lack of training programmes for local authorities assigned to protected areas. Institutionally, plans and policies on the conservation of genetic diversity by plant genetic diversity–related institutions have never been, to any significant extent, integrated into the policies and plans for utilization of natural resources. For example, the planting of identical species in both reforestation and agriculture projects by governmental agencies has increased pressure on the diversity of natural PGR. Many other governmental agencies also consider the issue of genetic diversity as mere "theory" and continue to undertake development activities that wastefully destroy PGR, such as transportation, energy production and irrigation, only to satisfy short-term economic return. Some other agencies, in response to accelerated economic development, even promote and support the harvesting of PGR with no regard to the long–term existence of such PGR. Therefore, strategies on this aspect should be clear and put in the national priority. Moreover, policy to support all needs should be taken into account.

From currently available information, the more acute needs for PGR conservation and utilization that may apply to most related institutions are summarized below.

5.1 Lack of a nation-wide and comprehensive survey on existing PGR, the doubtful state of their security, and the urgent needs in operational capacity and human power are areas for assessment and remedies. It is highly desirable for the country to have a national PGR center that will coordinate and integrate activities of various agencies having PGR components.

5.2 Lack of an effective and efficient information management system impairs periodic assessment of activities and effective control of genebank operations.

5.3 Lower-than-desired level of international collaboration on germplasm forfeits the potential advantages of sharing information, PGR, and technical expertise.

5.4 *In situ* and on-farm conservation can supplement *ex situ* conservation efforts. NGOs, farm communities and schools can add to the forces of conservation.

5.5 The underuse of conserved germplasm can be alleviated by renewed efforts in conventional and mission-oriented research, evaluation and breeding. Biotech should be used as a tool not a solution to all problems.

5.6 Both biodiversity and PGD in major crop varieties of commercial crops should be restored to provide protection against long-range perils that may upset stable ecosystems.

5.7 Training of technical personnel is needed in all fields related to conservation and use.

5.8 Collections must be managed. Elimination of administrative differences would promote cooperation among all centers and would simplify the system's structure.

5.9 Curators with specific knowledge should be appointed for each major crop or crop group, and they should be given management responsibilities. There is now no plan to ensure that knowledgeable, suitably trained curators oversee acquisition and management of the major or essential collections in the national system At present some site managers oversee several crops. Curators must have specific knowledge about their crop plants and be familiar with their collection, documentation, regeneration, evaluation, and enhancement. They should work with the appropriate crop advisory committee and the leader of the PGRS to develop and implement plans for the management and enhancement of germplasm

5.10 PGRS must devote more of its resources to regenerating seed accessions. Regeneration of seed lots that have low germination is a continuing need. Regeneration of these samples is urgently needed. Where responsibility for providing fresh seed cannot be assigned to an existing site, funds should be available to secure regeneration on a contract basis with appropriate supervision and safeguards.

5.11 A plan should be developed for monitoring, supporting, and conserving important special conservation both *in situ* and *ex situ*. Both *in situ* and *ex situ* conservation have proved to be invaluable.

5.12 The management of large collections, such as those for rice, corn, and soybeans, could be aided by the identification of core subsets.

5.13 Funds should be made available for competitive, goal-directed research in areas of specific need.

5.14 Building capacity and empowerment of local communities are the foundations of sustainable natural resource management.

5.15 Address the problem of global loss of biological diversity. This can be done in significant part through conserving the PGD of crop species.

5.16 The National Seed Storage Laboratory must be expanded.

5.17 Facilities and programmes of the PGRS should undergo periodic external review.

5.18 Sites should be established for the growth and maintenance of PGR that require short term or long term conservation.

5.19 The PGRS should develop clear, concise goals and policies that encompass the conservation of PGR that reflect the world's biological diversity and crop resources of immediate use to scientists and breeders.

5.20 PGRS must take a more active role in developing national policies that guide relations with the FAO, international agricultural research centers, and other international agencies and national institutions.

5.21 The PGRS should cooperate with other nations to conserve, collect, maintain, and regenerate germplasm

5.22 The PGR Information Network must better reflect the collections of PGRS. FAO and related bodies dealing with PGRFA should have an international coordinating organization for exchanging genetic resources and should provide support in the following activities:

- Encouragement of cooperation among PGR researchers worldwide in order to have close relationships and access to data so that research and plant development is strengthened in each country for the benefit of the people of that country as well as for the world population.
- Encouragement of the exchange of PGR with good characteristics in each location, so that plant breeders worldwide can utilize genetic resources directly or use as parents for developing new varieties that can adjust to specific local conditions.
- Be a center for providing PGR data about the interaction of genotype and environment for community utilization
- Encouragement of cooperation among PGR researchers worldwide in order to promote close relationships and access to data so that research and plant development is strengthened in each country for the benefit of the people of that country as well as for the world population.
- Collaboration and contribution from international bodies are needed.

Annex 1 Planted area, production, and yield of major crops: 1997-2004

Crop	1997	1998	1999	2000	2001	2002	2003	2004	Annual Change %
Rice									
Area ('000 ha)	10,270	10,032	10,311	10,639	10,604	10,630	10,625	10,650	4.45
Production ('000 tonnes)	23,580	22,998	24,171	25,844	28,034	27,992	29,474	28,538	27.78
Yield (kg/ha.)	2,381	2,419	2,425	2,612	2,769	2,900	2,900	2,856	18.39
Maize									
Area ('000 ha)	1,397	1,441	1,235	1,248	1,930	1,171	1,111	1,126	-18.75
Production ('000 tonnes)	3,832	4,617	4,286	4,462	4,466	4,230	4,178	4,216	-6.99
Yield (kg/ha.)	3,200	3,344	3,555	3,675	3,737	3,687	3,856	3,869	12.13
Cassava									
Area ('000 ha)	1,265	1,071	1,152	1,185	1,107	996	1,030	1,081	-14.54
Production ('000 tonnes)	18,084	15,591	16,507	19,064	18,396	16,868	19,718	21,440	18.55
Yield (kg/ha.)	14,700	14,925	1,494	16,856	17,531	17,069	19,294	20,275	37.92
Sugarcane									
Area ('000 ha)	1,010	944	918	914	877	1,011	1,139	11,22	11.05
Production ('000 tonnes)	56,393	43,465	50,332	45,052	49,563	60,103	74,259	64,996	15.25
Yield (kg/ha.)	55,825	46,062	54,856	59,162	56,512	59,350	65,181	5,931	3.77
Soybean									
Area ('000 ha)	248	235	232	223	185	181	154	151	-44.28
Production ('000 tonnes)	338	321	319	312	261	260	231	218	-39.27
Yield (kg/ha.)	1,431	1,462	1,419	1,450	1,475	1,487	1,537	1,487	5.77
Oil palm									
Area ('000 ha)	177	205	215	230	243	263	288	302	85.23
Production ('000 tonnes)	2,578	2,523	3,413	3,343	4,097	4,001	4,903	5,182	98.46
Yield (kg/ha.)	14,519	12,275	15,856	14,531	16,869	15,212	17,031	16,762	6.93
Coconut									
Area ('000 ha)	317	314	314	325	326	274	260	254	-21.32
Production ('000 tonnes)	2,064	2,005	2,110	1,400	1,396	1,877	1,957	1,848	-19.33
Yield (kg/ha.)	6,512	6,394	6,712	4,300	4,281	6,856	7,512	7,262	2.46
Durian									
Area ('000 ha)	108	111	112	128	131	132	135	137	27.67
Production ('000 tonnes)	916	464	781	970	885	962	737	829	-9.69
Yield (kg/ha.)	9,234	4,675	7,687	9,237	7,919	8,337	6,250	6,887	-26.58
Mangosteen									
Area ('000 ha)	40	44	48	56	58	58	61	64	66.11
Production ('000 tonnes)	170	144	161	168	197	245	204	235	58.78
Yield (kg/ha.)	7,618	5,944	6,100	5,619	5,865	6,500	5,194	5,487	-23.31
Pineapple									
Area ('000 ha)	85	82	97	98	92	80	81	89	6.71
Production ('000 tonnes)	2,083	1,786	2,392	2,248	2,078	1,739	1,899	2,101	5.73
Yield (kg/ha.)	24,600	21,819	24,425	23,019	22,612	21,881	23,331	23,606	-0.79
Para rubber									
Area ('000 ha)	1,910	1,955	1,985	1,987	1,990	2,004	2,019	2,072	10.07
Production ('000 tonnes)	2,169	2,663	2,215	2,378	2,561	2,632	2,861	3,008	41.75
Yield (kg/ha.)	1,406	1,394	1,425	1,562	1,681	1,694	1,787	1,812	31.81

Annex 2 Planted area, production, and yield of minor crops: 1997-2004

Crop	1997	1998	1999	2000	2001	2002	2003	2004	Annual Change %
Sorghum									
Area ('000 ha)	108	98	89	92	86	74	52	52	-65.26
Production ('000 tonnes)	156	146	142	148	145	132	96	93	-58.66
Yield (kg/ha.)	1,500	1,506	1,637	1,731	1,737	1,844	1,875	1,812	8.2
Mungbean									
Area ('000 ha)	289	303	322	295	303	293	243	187	-40.84
Production ('000 tonnes)	200	226	249	226	238	216	178	135	-37.2
Yield (kg/ha.)	731	781	812	806	806	794	769	756	6.14
Groundnut									
Area ('000 ha)	86	89	90	85	69	72	47	41	-58.31
Production ('000 tonnes)	126	135	138	132	107	112	76	65	-55.78
Yield (kg/ha.)	1,544	1,562	1,587	1,594	1,619	1,631	1,650	1,625	5.69
Sunflower									
Area ('000 ha)	-	-	-	71	37	41	47	51	-27.7
Production ('000 tonnes)	-	-	-	51	32	29	32	49	-3.92
Yield (kg/ha.)	-	-	-	737	887	769	706	1906	158.47
Sesame									
Area ('000 ha)	91	62	62	63	63	63	64	64	3.10
Production ('000 tonnes)	35	36	37	39	39	40	40	41	20.58
Yield (kg/ha.)	569	581	600	619	612	625	637	644	15.73
Castor bean									
Area ('000 ha)	12	13	13	13	13	14	14	13	20.28
Production ('000 tonnes)	6	7	7	9	9	10	10	10	66.66
Yield (kg/ha.)	519	556	569	656	669	706	712	737	45.67
Kenaf									
Area ('000 ha)	67	30	19	18	33	24	21	17	-77.47
Production ('000 tonnes)	95	47	30	29	56	41	33	25	-77.06
Yield (kg/ha.)	1,469	1,606	1,737	1,750	1,719	1,739	1,631	1,531	0.40
Cotton	37	30	26	26	45	11	8	11	-80.41
Area ('000 ha)	51	40	35	36	61	14	11	14	-81.33
Production ('000 tonnes)	1,462	1,406	1,362	1,425	1,450	1,325	1,469	1,400	-4.27
Yield (kg/ha.)									
Gralic	27	24	22	22	24	23	21	16	-42.69
Area ('000 ha)									
Production ('000 tonnes)	147	119	118	126	1321	126	105	96	-34.69
Yield (kg/ha.)	5,462	5,087	5,456	5,794	5,581	5,725	5,037	6,181	13.15
Baby corn									
Area ('000 ha)	-	-	-	25	30	37	34	39	59.09
Production ('000 tonnes)	-	-	-	117	233	259	247	305	72.31
Yield (kg/ha.)	-	-	-	7,844	8,262	7,300	7,306	7,969	1.59
Shallot									
Area ('000 ha)	16	15	16	17	17	16	17	18	14.14
Production ('000 tonnes)	204	176	201	225	199	194	173	233	14.21
Yield (kg/ha.)	13,575	12,469	13,137	13,531	12,294	12,062	10,600	13,044	-3.91
Onion									
Area ('000 ha)	4	4	4	4	3	3	2	3	-33.33
Production ('000 tonnes)	112	92	78	90	78	69	38	89	-20.53
Yield (kg/ha.)	28,612	23,594	20,925	27,406	24,750	25,400	19,375	38,906	35.97

Annex 2 Planted area, production, and yield of minor crops: 1997-2004 (Cont.)

Crop	1997	1998	1999	2000	2001	2002	2003	2004	Annual Change %
Chili									
Area ('000 ha)	22	23	23	23	23	23	24	24	6.47
Production ('000 tonnes)	33	38	40	37	37	38	39	41	24.24
Yield (kg/ha.)	1,494	1,637	1,719	1,631	1,606	1,361	1,669	1,737	17.79
Tomato									
Area ('000 ha)	10	9	11	11	11	11	8	8	-5.88
Production ('000 tonnes)	165	175	219	236	240	280	176	180	-4.25
Yield (kg/ha.)	16,525	19,812	23,294	23,956	22,969	27,231	24,012	24,050	1.20
Potato									
Area ('000 ha)	5	6	7	9	9	8	7	7	33.33
Production ('000 tonnes)	90	93	90	100	91	97	87	100	11.11
Yield (kg/ha.)	17,125	1,669	12,350	13,075	1,287	12,069	13,006	14,319	-16.38
Banana									
Area ('000 ha)	-	-	-	14	14	14	14	14	8.51
Production ('000 tonnes)	-	-	-	174	234	226	217	218	25.28
Yield (kg/ha.)	-	-	-	17,369	19,150	19,487	18,556	16,619	-4.31
Rambutan									
Area ('000 ha)	86	90	93	85	86	86	86	85	19.05
Production ('000 tonnes)	276	643	569	645	649	631	610	564	-13.49
Yield (kg/ha.)	11,031	9,431	8,219	8,179	8,519	8,229	7,819	7,237	-34.42
Longan									
Area ('000 ha)	-	-	-	91	101	127	167	146	59.89
Production ('000 tonnes)	-	-	-	417	250	430	369	597	43.16
Yield (kg/ha.)	-	-	-	6,169	3,256	4,919	3,725	5,487	-11.04
Coffee bean									
Area ('000 ha)	71	71	75	76	78	78	76	74	4.72
Production ('000 tonnes)	84	78	55	81	86	53	54	62	-26.19
Yield (kg/ha.)	1,244	1,194	831	1,200	1,244	762	762	869	-30.15
Pepper									
Area ('000 ha)	2	2	2	3	5	4	4	4	83.33
Production ('000 tonnes)	5	5	7	7	9	10	13	13	160
Yield (kg/ha.)	3,356	3,350	4,081	3,406	4,162	4,181	4,025	4,106	22.34
Tobacco									
Area ('000 ha)	20	19	14	13	11	11	10	10	-45.45
Production ('000 tonnes)	228	176	161	151	170	165	143	137	-38.28
Yield (kg/ha.)	11,681	9,481	11,700	11,650	15,856	14,731	13,962	14,269	13.13
Orchid									
Area ('000 ha)	2,323	2,240	2,262	2,515	2,728	2,961	3,130	3,165	37.38
Production ('000 tonnes)	26,825	25,200	29,575	33,890	37,602	40,852	43,247	43,932	64.90
Yield (kg/ha.)	11,562	11,250	13,075	13,475	13,787	13,800	13,819	13,881	20.05

Annex 3 The core institutions and persons responsible for formulating the report

Part of the report	Name	Title	Organization
The executive summary and introduction	Mr. Wichar Thitiprasert	Director of PVPD	PVPD, DOA
	Ms. Chutima Ratanasatien	Senior Agricultural Scientist	PVPD, DOA
Chapters 5-7, the state of national programmes, training needs and legislation, the state of regional and international collaboration and access to PGRFA	Ms. Thidakoon Saenudom	Agricultural Scientist	PVPD, DOA
	Ms. Rungthiwa Thanamtat	Agricultural Scientist	PVPD, DOA
Chapter 1, the state of diversity	Dr. Songkran Chitrakon	Project Consultant	
	Dr. Suchitra Changtragoon	Senior Forest Researcher	DNP
	Ms. Chutima Ratanasatien	Senior Agricultural Scientist	PVPD, DOA
Chapter 2, the state of *in situ* management	Dr. Suchitra Changtragoon	Senior Forest Researcher	DNP
	Dr. Prasartporn Samitaman	Associate Professor	CMU
Chapter 3, the state of *ex situ* management	Dr. Somsong Chotechuen	Agricultural Scientist	BRDO, DOA
	Ms. Orapin Watanesk	Senior Agricultural Scientist	RRI, DOA
Chapter 4, the state of use	Dr. Veerana Sinsawat Forrer	Agricultural Scientist	FCRI, DOA
	Dr. Songpol Somsri	Senior Agricultural Scientist	HRI, DOA
Chapter 8, the contribution of PGRFA management to food security and sustainable development	Mr. Wichar Thitiprasert	Director of PVPD	PVPD, DOA
	Ms. Chutima Ratanasatien	Senior Agricultural Scientist	PVPD, DOA
	Ms. Wilailak Sommut	Senior Agricultural Scientist	RRI, DOA

Annex 4a Edible plants in limestone areas in Thailand

No.	Scientific name	Common Name	Plant part used
1	*Amorphophallus paeoniifolius* (Dennts) Nicolson	Stanley's water-tub	corm
2	*Acacia concinna* (Wild.)DC.	Shikakai	apical, young leaf
3	*Acacia pennata* (L.) Wild. ssp. *insuavis* (Lace) I.C. Nielsen	Cha-om	young apical
4	*Aganonerion polymorphum* Pierre ex Spire	Som lom	young apical
5	*Aganosma marginata* (Roxb.) G.Don	Mok khruea	young apical
6	*Archidendron jiringa* (Jack) I.C.Nielsen	Djenkol bean	seed
7	*Albizia lebbeck* (L.) Benth.	East Indian walnut	young apical
8	*Aeginetia indica* Roxb.	Ye gu	flower
9	*Aeginetia pedunculata* Wall.	Dok din	flower
10	*Arenga pinnata* (Wurmb) Merr.	Sugar Palm	seed
11	*Atherolepis pierrie* Costa var. *glabra* Kerr	Op choei	young fruit
12	*Ardisia fulva* King & Gamble var. *fulva*	Hua khwan	young apical,young leaf
13	*Amaranthus caudatus* L.	Love-lies bleeding	young apical,young leaf
14	*Amaranthus spinosus* L.	Spiny pigwood	young apical,young leaf
15	*Amaranthus tricolor* L.	Chinese amaranth	young apical,young leaf
16	*Amaranthus viridis* L.	Slender amaranth	young apical,young leaf
17	*Asparagus acerosus* Roxb.	Chan din	
18	*Asparagus racemosus* Willd.	Sam sib	storage root
19	*Aegle marmelos* (L.) Correa ex Roxb.	Bael	young apical,fruit
20	*Antidesma acidum* Retz.	Mao soi	young apical,fruit
21	*Aesculus assamica* Griff.	Ma niang nam	young fruit
22	*Bombax ceiba* L.	Cotton tree	flower
23	*Basella rubra* L.	Pak plang	young apical,young leaf
24	*Barringtonia acutangula* (L.) Gaertn.	Chik na	young flower, young leaf
25	*Barringtonia asiatica* (L.) Kurz	Sea putat	young flower, young leaf
26	*Bambusa* spp.	Bamboo	
27	*Bauhinia variegata* L.	Mountain ebony	young apical, flower
28	*Baccaurea bracteata* Müll.Arg.	Ramai pa	fruit
29	*Baccaurea ramiflora* Lour.	Mafai	fruit
30	*Brassaiopsis ficifolia* Dunn	Tang duea	young flower
31	*Cratoxylum formosum* (Jack) Dyer	Tio khao	young apical
32	*Castanopsis* spp.	Chinquapin	seed
33	*Caesalpinia furfuracea* (Prain) Hattink	Nguam	fruit
34	*Caesalpinia mimosoides* Lam	Cha rueat	young apical
35	*Clausena excavata* Burm f.	Saen sok	young apical,young leaf
36	*Clausena harmandiana* (Pierre) Pierre ex Guillaumin		young apical,young leaf

Annex 4a Edible plants in limestone areas in Thailand (Cont.)

No.	Scientific name	Common Name	Plant part used
37	*Clausena lansium* (Lour.) Skeels	Song fa dong	fruit
38	*Careya sphaerica* Roxb.	Tummy-wood	young apical, young leaf
39	*Curcuma aeruginosa* Roxb.	Wan mahamek	young apical
40	*Curcuma parviflora* Wall.	Krachiao khao	young apical
41	*Dimocarpus longan* Lour. ssp. *longan* var. *longan*	Longan	sarcocarp
42	*Dolichandrone serrulata* (DC.) Seem	Khae khao	flower
43	*Dendrocalamus* spp.	Bamboo	young apical, young leaf
44	*Dioscorea alata* L.	Water yam	corm
45	*Dioscorea esculenta* (Lour.) Burkill	Yam	corm
46	*Dioscorea hispida* Dennst. var. *hispida*	Intoxicating yam	corm
47	*Dioscorea pentaphylla* L.	Fiveleaf yam	corm
48	*Emilia sonchifolia* (L.) DC.	Emilia	young apical, young leaf
49	*Erythrina variegata* L.	Variegated coral tree	young apical, young leaf
50	*Eryngium foetidum* L.	False coriander	young apical, young leaf
51	*Fernandoa adenophylla* (Wall. ex G.Don) Steenis	Khae nang khang	flower
52	*Ficus virens Aiton* var. *virens*	Phak lueat	young apical, young leaf
53	*Flacourtia indica* (Burmf.) Merr.	Ta khoppa	fruit
54	*Flacourtia jangomas* (Lour.) Rausch	Ta khopkhwai	fruit
55	*Flacourtia rukam* Zoll. & Moritzi	Rukam	fruit
56	*Garcinia cowa* Roxb. ex DC.	Cha muang	young apical, young leaf
57	*Hydnocarpus ilicifolia* King	Kra baoklak	fruit
58	*Hydnocarpus wrayi* King	Chaulmoogra	fruit
59	*Hypoxis aurea* Lour.	Ya dok kham	fruit
60	*Houttuynia cordata* Thunb.	Phak khao tong	young apical, young leaf,root
61	*Hydrocotyle siamica* Craib	Phak nok	young apical, young leaf
62	*Irvingia malayana* Oliv. ex A.W.Benn.	Krabok	seed
63	*Kaempferia galanga* L.	Galanga	young apical
64	*Kaempferia rotunda* L.	Wan hao non	young apical
65	*Kaempferia parviflora* Wall. ex Baker	Krachai dam	
66	*Lasia spinosa* (L.) Thwaites	Livid Flower	young apical, young leaf
67	*Melientha suavis* Pierre	Phak wan	young apical, young leaf
68	*Millettia brandisiana* Kurz	Kra phi chan	young apical, young leaf
69	*Millettia leucantha* Kurz var. leucantha	Kra cho	young leaf, fruit
70	*Morus alba* L.	Mulberry Tree	young leaf, fruit
71	*Morus macroura* Miq.	Mon laung	young apical, young seed
72	*Oroxylum indicum* (L.) Kurz	Damocles Tree	young apical, young leaf
73	*Paederia linearis* Hook. f.	Tot mu totma	seed
74	*Phoenix humilis* Royle	Peng doi	fruit
75	*Phyllanthus emblica* L.	Malacca Tree	petal

Annex 4a Edible plants in limestone areas in Thailand (Cont.)

No.	Scientific name	Common Name	Plant part used
76	*Rhododendron lyi* H.Lév.	Dok sam si	petal
77	*Rhododendron arboreum* Sm ssp. *delavayi* (Franch.) Chamb.	Kham daeng	petal
78	*Radermachera ignea* (Kurz) Steenis	Tree Jasmine	flower
79	*Siphonodon celastrineus* Griff.	Maduk	fruit
80	*Syzygium gratum* (Wight) S.N. Mitra var. *gratum*	Samet chun	young apical, young leaf
81	*Schleichera oleosa* (Lour.) Oken	Ceylon oak	fruit
82	*Sauropus androgynus* (L.) Merr.	Phak wan pa	young apical, young leaf
83	*Sarcostemma secamone* (L.) Bennet	Chamuk pla lot	young apical, young leaf, flower
84	*Spondias pinnata* (L.f.) Kurz	Makok	young apical, young leaf,fruit
85	*Saraca indica* L.	Asoka Tree	young apical, young leaf
86	*Saraca thaipingensis* Cantley ex Prain	Yellow Saraca	young apical, young leaf
87	*Syzygium cumini* (L.) Skeels	Jambolan Plum	fruit, young leaf
88	*Toddalia asiatica* (L.) Lam	Khruea ngu hao	young apical, young leaf
89	*Tiliacora triandra* (Colebr.) Diels	Thao yanang	young apical
90	*Trachycarpus oreophilus* Gibbons & Spanner	Kho doi	young apical
91	*Tetrastigma quadrangulatum* Gagnep. & Craib	A ngun pa	Fruit
92	*Trevesia palmata* (Roxb. ex Lindl.) Vis.	Tang luang	
93	*Telosma minor* Craib	Cowslip Creeper	
94	*Vitex glabrata* R.Br.	Khai nao	fruit
95	*Xantolis siamensis* (H.R. Fletcher) P.Royen	Fern tree	fruit
96	*Zanthoxylum limonella* (Dennst.) Alston	Kamchat ton	seed coat
97	*Ziziphus oenoplia* (L.) Mill. var. *oenoplia*	Lep yiao	fruit

Annex 4b List of some economic wild fruit tree species and their distributions in 47 National Parks in Thailand

Location of National Parks in Thailand	Wild Fruit Tree Species		
	Mangifera sp.	*Garcinia* sp.	*Nephelium* sp.
Northern	*M calneura* *M indica* *M latifolia* *M pentandra* *M sylvatica*	*G. coronaria* *G. cowa* *G. hombroniana* *G. merguensis* *G. rostrata* *G. sootepensis* *G. speciosa* *G. xanthochymus*	*N. hypoleucum* *N .maingayi*
Central/ Western/ Eastern	*M caloneura* *M indica* *M latifolia* *M pentratandra*	*G. cowa* *G. speciosa* *G. hanbury* *G. turgida* *G. collinsae* *G. ostata* *G. mangostana* *G. speciosa* *G. hanbury* *G. dulcis*	*N. foramosana* *N. hypoleucum* *N. appaceum* *N. melliferum* *N. maingayi* *N. hypoleucum*
Northeastern	*M caloneura* *M latifolia* *M longipetiolata*	*G.cowa* *G.speciosa*	*N. hypoleucum*
Southern	*M foetida* *M caloneura* *M oetida* *M indica* *M longipertiolata* *M. sylvatica*	*G. costata* *G. cowa* *G. hombroniana* *G. merguensis* *G. obtusifolia* *G. speciosa* *G. tubifera*	*N. hypoleucum* *N. lappaceum*

Annex 5 Priority areas and crops for survey and inventory of PGRFA

Fruit crops

Crop	Area	Remark (1 rai=0.625 ha)
Durian	Chanthaburi HRC	*In situ* collection for 20 rai
	Nakorn Phanom Technical and Agricultural Production Service Center	Research station
	Chumporn HRC	Research station
Longan	Chiangrai HRC	*In situ* collection for 20 rai
	Chiang Mai Royal Agricultural Center	*In situ* collection for 40 rai
	Nakorn Phanom Technical and Agricultural Production Service Center	Research station
Mangosteen	Chanthaburi HRC	*In situ* collection for 5 rai
	Trung HRC	*In situ* collection for 1.5 rai
	Nakorn Phanom Technical and Agricultural Production Service Center	Research station
Pomelo	Phichit HRC	*In situ* collection for 10 rai
	Sukhothai Technical and Agricultural Production Service Center	Research station
	Burirum 4th Technical and Agricultural Production Service Center	Research station
Coconut	Chumporn HRC	Research station
	Kanchanaburi Technical and Agricultural Production Service Center	Research station
	Sukhothai Technical and Agricultural Production Service Center	Research station
Mango	Burirum 2nd Technical and Agricultural Production Service Center	*In situ* collection for 30 rai
	Phichit HRC	*In situ* collection for 30 rai
	Kanchanaburi Technical and Agricultural Production Service Center	*In situ* collection for 35 rai
Rambutan	Chanthaburi HRC	*In situ* collection for 12 rai
	Trung HRC	*In situ* collection for 30 rai
Pineapple	Petchaburi Technical and Agricultural Production Service Center	*In situ* collection for 2.5 rai
	Phuket Technical and Agricultural Production Service Center	Research station
Indigenous fruit	Phichit HRC	*In situ* collection for 2 rai
	Nakorn Phanom Technical and Agricultural Production Service Center	*In situ* collection for 180 rai
	Nan Technical and Agricultural Production Service Center	*In situ* collection for 11 varieties

Annex 5 Priority areas and crops for survey and inventory of PGRFA (Cont.)

Field crops

Crop	Area	Remark
Wild rice	Prachinburi RRC	*In situ* collection for 600 rai
	Sakolnakorn RRC	*In situ* collection for 87 rai
	Chainat Rice Experiment Station	Research station
Cassava	Rayong FCRC	*In situ* collection for 2 rai
	Khonkhaen FCRC	Research station
	Prachinburi Technical and Agricultural Production Service Center	Research station
Sugarcane	Suphanburi FCRC	*In situ* collection for 2 rai
	Prachinburi Technical and Agricultural Production Service Center	Research station
	Khonkhaen FCRC	Research station
Rubber	Surasthani Rubber Research Center	*In situ* collection for 100 rai
	Nongkai Rubber Research Center	*In situ* collection for 40 rai
	Chacherngsao Rubber Research Center	*In situ* collection for 50 rai
Coffee	Chumporn HRC	*In situ* collection for 5 rai
	Chiangrai Technical and Agricultural Production Service Center	*In situ* collection for 20 rai
	Tak Technical and Agricultural Production Service Center	*In situ* collection for 10 rai
Ramie	Khonkhaen FCRC	*In situ* collection for 1 rai
Kenaf	Chiang Mai FCRC	*In situ* collection for 3 rai
	Kalasin Technical and Agricultural Production Service Center	*In situ* collection for 10 rai
Oil palm	Surasthani Oil Palm Research Center	Field collection for 50 varieties
	Nakornsrithamaraj Technical and Agricultural Production Service Center	Research station

Medicinal plants

Crop	Area	Remark
Medicinal plant	Chumporn HRC	*In situ* collection for 6 rai
	BRDO	*In situ* collection for 6 rai

Annex 6 Endemic fern species

Family	Scientific name	Habitat	Locality
SELAGINELLACEAE	*Selaginella lindgardii*	Terrestrial in bamboo forest or on shady brick walls at low altitudes.	Tak, Bangkok, Ratchaburi
HYMENOPHYLLACEAE	*Crepidomanes megistostomum*	On wet rocks in tropical evergreen forest at about 500 m alt.	Thung Salaeng Luang; Phitsanulok; Phangnga
PAKERIACEAE	*Cheilanthes delicatula*	No record of habitat, probably in crevices of rocks.	Doi Inthanon, Chiang Mai
	Cheilanthes siamensis	On limestone cliffs at 350-500 m alt.	Doi Suthep, Chiang Mai
	Cheilanthes pseudoarqentea	On calcareous rocks on clifs of mountain ridges near summit, 1,900-2,100 m alt.	Doi Chiang Dao, Chiang Mai
ADIANTACEAE	*Adiantum siamense*	On limestone cliffs in light shade at low altitudes near Thung Song, known only in this locality	Thung Song, Nakhon Si Thammarat
VITTARIACEAE	*Antrophyum winitii*	Gregarious on bark of trees in semi-evergreen jungle at 520 m alt.	Chiang Rai
PTERIDACEAE	*Pteris phuluangensis*	On rather dry slopes in dry evergreen forest at about 800 m	Phu luang, Loei
ASPLENIACEAE	*Asplenium siamense*	Sandstone rock at about 1,300 m alt. know only from the type collection	Phu Kradung, Loei
LOMARIOPSIDACEAE	*Elaphoglossum dumrongii*	On moist cliffs by streams or on mossy rocks in stream-beds in dense evergreen forest at about 1,100-1,200 m alt.	Phu Kradung, Loei
	Lomagramma grossoserrata	At 620-880 m alt.	Phrae
DRYOPTERIDACEAE	*Polytichum attenuatum*	Terrestrial on humus-rich mountain slopes in dense evergreen forest at 1,200-1,800 m alt.	Chiang Mai; Loei; Kanchanaburi
	Dryopteris rheophila	On sandstone boulders in streamlets at 1,000-1,200 m alt.	Chiang Rai; Chiang Mai
	Heterogonium hennipmanii	Moist evergreen forest along streamlets, ca 800 m alt.	Doi Musoe, Tak
	Tectari gymnosora	Terrestrial near streams in evergreen forest, 700-800 m alt.	Phitsanulok; Nakhon Nayok
	Ctenitis dumrongii	On moist banks of streamlets in dense evergreen forest at medium altitudes	Loei
THELYPTERIDACEAE	*Thelypteris siamensis*	On humus-rich mountain slopes in evergreen forest at 1,200-1,400 m alt	Phetchabun; Loei
ATHYRIACEAE	*Diplazium siamense*	On humus-rich mountain slopes in mixed or evergreen forest at 850-1,500 m alt	Chiang Mai; Vhiang Rai; Phitsanulok; Phrae; Phetchabun; Loei

Annex 6 Endemic fern species (Cont.)

Family	Scientific name	Habitat	Locality
POLYPODIACEAE	*Pyrroia heteractic* var. *minor*	On mossy tree-trunks or on rocks on ridges in evergreen forest at high altitudes (1,400-2,000 m)	Chiang Mai; Tak; Phitsanulok
	Lepisorus oosphaerus	On branches of trees at 1,500-1,650 m alt.	Chiang Mai
	Crypsinus hirsutus	Gregarious on rocks or rocky soil in exposed or comparatively dry places as well as in shaded or moist situations at 1,000-1,800 m alt.	Chiang Rai; Chiang Mai; Phitsanulok
	Arthromis phuluangensis	On mossy tree trunks or on mossy rocks in evergreen forest on ridges at 1,500-1,600 m alt.	Phitsanulok, Loei
	Polypodium garrettii	On mossy tree-trunks in dense forests in limestone areas at 1,000-1,800 m alt.	Chiang Mai
GRAMMITIDACEAE	*Xiphopteris khaoluangensis*	On mossy tree-trunks in dense evergreen on ridges at high altitude	Nakhon Si Thammarat; Yala

Annex 7 Endemic monocotyledon species

Family	Scientific name	Habitat	Locality
APOSTTASIACEAE	*Neuwiedia siamensis*	River valleys, between 400 and 800 m altitude	Kanchanaburi; Ratchaburi
LOWIACEAE	*Orchidantha siamensis*	The author has collected the species near Bacho Falls, at the type locality. Here it grows in black humus soil in evergreen forest near waterfall on the forest floor over large areas	Narathiwat; Phatthaluung
TRIURIDACEAE	*Sciaphila thaidanica*	Near streams in evergreen hillside forest on black humus soil.	Doi Suthep; Chiang Mai
SMILACACEAE	*Smilax zeylanica* var. *bemsleyana*	Tropical evergreen forest at altitudes of 600 to 1,100 m	Doi Inthanon, Doi Suthep, Chiang Mai
	Smilax siamensis	Tropical evergreen forest up to 1,100 m	Chiang Mai, Kanchanaburi
	Smilax micro-china	Open grassy pine forest at 1,300 m	Phu Kradung; Loei
XYRIDACEAE	*Xyris kradungensis*	In open, grassy pine forests at 1,300 m altitudes	Phu Kradung; Loei
CYPERACEAE	*Fimbristylis smitinandii*	Sandy soil at edge of sandstone rocks, 100 m	Nong Khai
	Fimbristylis prabatensis	In seasonally wet area over rocks on margin of dry deciduous dipterocsrp forest, ca 200 m	Udon Thani
	Fimbristylis sleumeri	Swampy grassland, pine savanna, 1,300 m	Loei
	Fimbristylis savannicola	Savanna grassland, 1,100 m	Loei
	Fimbristylis trichoides	Shallow water in open bog pools, generally growing with mosses, up to 1,300 m	Nakhon Ratchasima; Prachin Buri
	Fimbristylis spicigera	Sandy river banks, 200 m	Nakhon Phanom
	Fimbristylis psammophila	Sand river banks, 200 m	Nakhom Phanom
	Fimbristylis brunncoides	Sandy river banks, 200 m	Nakhon Phanom
	Schoenus smitinandii	Wet ground, 150 m	Roi Et
	Carex indica var. *microcarpa*	Forest, 1,100 m	Chiang Mai
	Carex subinclinata	Evergreen and bamboo forest, 1,100-1,300 m	Phetchabun; Loei
	Carex thailandica	Dry evergreen forest, 100-500 m	Phetchabun; Nakhon Ratchasima; Saraburi; Phetchaburi
	Carex cataphyllodes	Evergreen forest, 1,200-1,300 m	Kanchanaburi
	Carex juvenilis	Open areas in dry mixed or evergreen forest, 200-600 m,	Phitsanulok; Phetchaburi
	Carex phyllocayla	In thickets and open grassy ground, 1,500-2,100 m	Chiang Mai
	Carex speciosa subsp. *platyrrhina*	Forest, scrub or open grassy hillsides, 800-2,500 m	Chiang Mai; Nakhon, Ratchasima
	Carex speciosa subsp. *latifolia*	Forest, scrub or open grassy hillsides, 1,100-1,200 m	Chiang Mai; Chaiyaphum
	Carex lageniformis	Evergreen forest, along river margins, 600-1,400 m	Sakon Nakhon ; Chaiyaphum; Chanthaburi

Annex 8 Endemic dicotyledon species

Family	Scientific name	Habitat	Locality
SCHISANDRACEAE	*Kadsura ananosma*	Altitude 1,460 m	Doi Inthanon; Chiang Mai
THEACEAE	*Gordonia dalglieshiara*	In or along the edge of evergreen forest from low to medium altitude (900-2,100 m)	Doi Suthep, Doi Inthanon; Chang Mai, Phangnga, Trang
	Camellia connata	In evergreen forest, often by streams or shaded places from low to medium altitudes (800-2,000 m)	Chiang Mai, Loei, Saraburi, Ranong, Surat Thani
	Pyrenaria garrettiana	Scattered in dry or bumid mixed evergreen forest, altitudes 100-1,850 m	Chiang Mai, Kanchanaburi, Ranong
	Adinandra oblonga	The peninsular regions are characterized by plant with much shorter (less than 8 mm long) pedicels	Sukhothai, Nakhon si Thammarat, Pattani, Songkhla, Trang
	Eurya nitada var. *siamensis*	On edges and slopes in open grassy or evergreen forests, from low to medium alt. (800-1,800 m)	Doi Suthep; Chiang Mai, Loei, Chaiyaphum, Nakhon Ratchasima
MEGNOLIACEAE	*Manglietia garrettii*	In lower montane forest, on bamboo covered hilsl or near crests of ridges at medium alt. (1,320-1,850 m)	Doi Inthanon; Chiang Mai
	Talauma siamensis	In tropical evergreen forest at low (50-800 m) altitude, often by streams, also on limestone hills	Chanthaburi, Trar, Kanchanaburi
	Michelia rajaniana	In lower montane forest, or found on the edge of hill slope, at medium altitudes (1,000-1,300 m)	Chiang Mai, Phrae
EBENACEAE	*Diospyros bambuseti*	In upper mixed deciduous forest alt. 50 m	Prachin Buri
	Diospyros kerrii	In dry evergreen forest, alt. 500-1<00 m	Chiang Mai, Phetchabun
	Diospyros winitii	In dry evergreen forest, alt. 200-1,000 m	Chiang Mai, Lampang, Nan, Phitsanulok, Tak
	Diospyros gracilis	In dry evergreen forest, on limestone, alt. 50-300 m	Nakhon Ratchasima, Lop Buri, Saraburi
	Diospyros pubicalix	In scrub forest, alt. 10-50 m	Surat Thani
	Diospyros fulvopilosa	Near streams in evergreen forest, alt. 50-100 m	Krabi; Satun
	Diospyros coactanea	In mixed deciduous forest, alt. 300-400 m	Mae Hong Son; Lampang; Phitsanulok
	Diospyros scalaiformis	In evergreen forest, alt. 150-300 m	Surat Thani
	Diospyros collinsae	In tropical evergreen forest, alt. 50 m	Chon Buri; Narathiwat
	Diospyros longepilosa	In scrub and evergreen forest, near the sea, alt. under 50 m	Ranong
	Diospyros thaiensis	In evergreen forest, alt. 200-300 m	Ranong

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
LEGUMINOSAE-CAESALPINIOIDEAE	*Bauhinia viridescens* var. *hirsute*	Along limestone ridges from Three Pagodas Pass to Kanchanaburi	Kanchanaburi
	Bauhinia winitil	Dry open deciduous forest and thorny scrub	Nakhon Sawan; Saranburi; Kanchanaburi
	Bauhinia strychnifolia	In lowland deciduous dipterocarp forest and savanna. In areas that are burned annually this species becomes a prostrate shrub; also along roadside at lower altitudes	Chiang Mai, Kamphaeng Phe;, Lampang; Nakhon Sawan; Sukhothai
	Bauhinia tubicalyx	On limestone rocks in evergreen forests at lower altitudes	Surat Thani; Krabi
	Bauhinia concreta	Limestone hills, at 50-250 m alt.	Surat Thani; Krabi
	Pterolobium micranthum	In thickets, fringes, hedges at low attitudes	Prachuap Khirikhan
	Crudia speciosa	Lowland tropical rain forest under 100 m alt.	Phangnga; Surat Thani
LEGUMINOSAE-MIMOSOIDEAE	*Acacia craibii*	Along streams in dry evergreen forest, alt. 150 m	Kanchanaburi
	Pithecellobium tenue	Recorded both from poor mixed deciduous forests and bamboo jungles in limestone areas and from dry evergreen forests on granitic rock, alt. 200-900 m	Tak; Nakhon Sawan; Kanchanaburi
ARISTOLOCHIACEAE	*Aristolochia helix*	On limestone rocks	Phagnga; Krabi
	Aristolochia kerrii	All type of forests, up to 1,370 m alt.	Chiang Mai, Phayao, Mae Hong Son, Khon Kaen, Kanchanaburi, Surat Thani
	Aristolochia grandis	In evergreen and dry evergreen forests often by streams, at 750-1,300 m alt.	Doi Suthep; Chiang Mai
BIGNONIACEAE	*Barnettia pagetii*	Confined to dry limestone hills	Bangkok; Phetchburi; Ratchaburi; Kanchanaburi; Uthai Thani
	Barnettia kerrii	Confined to dry limestone hills	Nakhon Sawan; Khon Kaen; Saraburi
GENTAINACEAE	*Cnascora hexagona Hosseus*	At foot of rocks in shade, up to 300 m alt.	Chiang Mai; Nakhon Ratchasima
	Exacum sutaepense Hosseus	Open grassy ground, at 1,500-1,700 m alt.	Doi Suthep; Chiang Mai, Kanchanaburi
	Exacum sutaepense forma *gracile*	Shrubby ridges on crests, at ,200-1,300 m alt.	Ranong
	Gentiana arenicola	Open grassy deciduous forests, at 200-1,300 m alt.	Sakon Nakhon; Loei
	Gentiana leptoclada subsp *australis*	Common on rocky ground, between 1,650-1,770 m alt.	Doi Chiang Dao; Chiang Mai
	Gentiana hesseliana var. lakshnakarae	Open pine forests, at about 1,200 m alt.	Phu Luang; Loei
	Gentiana timida	Grassland in open forests, at 1,500 m alt.	Doi Suthep; Chiang Mai
	Swertia calcicola	On rocks, at 2,000-2,100 m alt.	Doi Chiang Dao; Chiang Mai

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
SCROPHULARIACEAE	*Limnophila parviflora*	In meadows at 50-100 m alitude	Kanchanaburi
	Limnophila siamensis	In small ponds at low altitude	Kamphaeng Phet, Nakhon Nayok
	Limnophila hayatae	In ponds and marshes at low altitude	Chiang Mai, Phitsanulok, Prachuap Khirikhan, Surat Thani
	Limnophila verticillata	In marshes at low altitude	Nakhon Ratchasima, Yaso Thon
	Lindernia rivularis	In shallow streams, half floating, at low altitude	Lop Buri, Kanchanaburi
	Lindetnia satakei	On limestone areas with moderate humidity at low altitude	Saraburi
	Lindernia maxwellii	Open sandy places in degraded dry evergreen forest, at 200 m altitude.	Si Sa Ket
	Lindernia khaoyaiensis	Open boggy places on sandstone in rather dense vegetation, at altitudes of 1,200 m	Mukda Han, Nakhon Ratchasima
	Lindernia udawnensis	Sandstone plateau with open grassland and sattered scrub, at alt. of 1,200-1,400 m	Phu Luang, Phu Ruea, Phu Kradung; Loei
	Lindernia cephalantha	Open, dry deciduous dipterocarp forest, altitude 250 m	Phu Kradung; Loei, Buri Ram
	Scolophyllum spinifidum	On sandy soil and in ricefields, at 200 m altitude 250 m	Phu Kradung; Loei, Buri Ram
	Torenia thailandica	Open grassy ground, at 600 m altitude.	Trat
	Torenia ranongensis	On shrubby ridges of evergreen forests, at altitude 200-1,300 m	Ranong, Songkhla
	Torenia siamensis	Humid ground in dry dipterocarp forests and in *Pinus* forests, at altitude of 500-1,100 m	Phitsanulok, Phetchabun, Chaiyaphum
	Centranthera siamensis	Moist ground in evergreen or dry deciduous forests, from 200 to 1,300 m	Phu Kradung; Loei, Kanchanaburi
	Pedicularis siamensis	Open rocky ground with stunted trees in limestone areas, at altitude 1,800-2,100 m	Doi Chiang Dao; Chiang Mai
	Pedicularis thailandica	In evergreen forest at altitude of 1,800-2,000 m	Doi Chiang Dao, Doi Inthanon; Chiang Mai
BRETSCHNIE-DERACEAE CAPPARACEAE	*Capparis echinocarpa*	Common in evergreen forest, mixed deciduous forest, bamboo forest and on rocky limestone hills, alt. 50-750 m	Phetchabun, Chiyaphum, Nakhon Ratchasima, Saranuri, Prachin Buri, Kanchanaburi, Phetchaburi, Prachuap Khirikhan, Ratchaburi
	Capparis kerrii	Scattered beside streams in evergreen forest, alt. 300-1,500 m	Chiang Mai, Kanchanaburi
	Capparis klossii	In scrub, at low altitude	Ranong
	Capparis nomantha	Common in evergreen forest on limestone hills, alt. 100 m	Phet Chaburi, Prachuap Khirikhan

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
MALPIGHIACEAE	*Hiptage detergens*	On limestones hill in evergreen forest, at 200 m alt.	Phangnga
	Hiptage bullata	On limestone rock in scrub forest, 200-500 m alt.	Chiang Mai, Uttaradit
	Hiptage glabrifolia	In evergreen forest by river, at 180 m alt.	Chiang Mai
	Hiptage calcicola	On rocky limestone hill in dry evergreen forest, 10-50 m alt.	Pran Buri; Prachuap Khirikhan, Phangnga, Phatthalung
	Hiptage gracilis	In evergreen forest, at 650 m alt.	Chaiyaphum
	Hiptage monopteryx	In evergreen forest, at low altitude.q	Ko Chang; Trat
	Brachylophon anastomosans	Scattered in evergreen forest on limestone hills, at 50 m alt.	Yala
MENISPERNACEAE	*Albertisia puberula*	Shaded areas near rivers in primary rain forest, at 150 m alt.	Bakhon Si Thammarat
	Stephania tomentella	Growing on limestone rocks, at *ca* 525 m	Chiang Rai
	Stephania suberosa	Bamboo forest on rocky limestone hill, and evergreen scrub on rocky areas, at 400 m alt.	Kanchanaburi, Prachuap Khirikhan, Saraburi
	Stephania brevipes	In evergreen forests, sometimes along streams, at 400-1,200 m alt.	Doi Suthep; Chiang Mai, Kanchanaburi
	Stephania crebra	In mixed deciduous forests or secondary growth, sometimes by streams, at 700-1,200 m alt.	Chiang Mai
	Stephania papillosa	No information available	Nakhon Si Thammarat
	Cissampelos hispida	In evergreen forest, at 500-1,000 m	Chiang Mai
	Cyclea varians	In evergreen, dediduous or bamboo forest, sometimes on limestone, or climbing on rocks, at 250-1,000 m alt.	Chiang Mai, Lampang; Lamphun, Tak, Chaiyaphum, Nakhon Tatchasima
	Tinospora siamensis	In mixed deciduous forests, at 500 m	Nakhon Ratchasima
AMARANTHACEAE	*Siamosia thailandica*	In evergreen forest, also along streams, at low altitudes	Kanchanaburi, Takua Pa; Phngnga
	Achyranthes ancistrophora	Seems to be restricted to the dry dipterocarp-bamboo forest of central Thailand, occurring up to 800 m alt.	Khon Kaen, Kanchanaburi
UMBELLIFERAE	*Hydrocotyle chiangdaoenses*	Limestone summit ridges in dense	Doi Chiang Dao, Chiang Mai
	Peucedanum siamicum	Limestone rocky slopes and ridges, 1,100-2,200 m alt.	Doi Chiang Dao; Chiang Mai
TILIACEAE	*Grewia winitii*	In mixed deciduous forests, alt. 100-500 m	Lampang, Lanphun, Chaiyaphum, Kanchanaburi
	Corchorus siamicum	In open spaces, alt. 100-350 m	Tak, Phichit
	Burretiodendron umbellatum	In open areas	Muak Lek; Saraburi
	Schoutenia glomerata	In evergreen forest, at alt. 1,000 m	Doi Suthep, Chiang Mai.

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
MYRSINACEAE	*Ardisia impressa* var. impressa	In evergreen and mixed forest alt. 400-850 m	Chiang Mai, Loei, Saraburi, Trat, Kanchanaburi
	Ardisia impressa var. grandidens	In evergreen forest to 500 m altitude	Nakhon Ratchasima, chon Buri, Prachin Buri
	Ardisia undulatodentata	In lowland evergreen forest	Surat Thani
	Ardisia congesta	In lowland evergreen forest	Chumphon
	Ardisia betongensis	In evergreen forest alt. 1,100 m	Yala
	Ardisia kerrii	In evergreen jungle by streams alt. 500-660 m	Chiang Mai
	Ardisia fletcherii	In evergreen forest	Uthai Thani
	Ardisia eglandulosa	In evergreen forest alt. 300-950 m	Phetchabun, Nakhon Ratchasima, Chanthaburi
	Ardisia nervosa	In evergreen forest and disturbed forest, frequently on limestone hill; alt. 200-900	Chiang Mai, Nakhon Nayok, Kanchanaburi, Nakhon Ratchasima
	Ardisia punicea	In evergreen forest; alt. 333-1,200 m	Ranong, Narathiwat
	Ardisia rubroglandulosa	In evergreen forest; alt. 200 m	Chiang Mai
	Ardisia ferrygineopolosa	In evergreen forest; alt. 150-400 m	Nakhon Si Thammarat, Narathiwat, Songkhla, Pattani
	Ardisia tristis	In mixed deciduous forest; alt.ca 200 m	Nakhon Phanom
	Ardisia integra	In evergreen forest at low altitudes	Surat Thani
	Ardisia paralleloneura	In evergreen forest; alt.150-400 m	Narathiwat
	Ardisia puberula	In evergreen forest; alt. ca 300 m	Pattani
	Ardisia tetramera	In evergreen forest; alt. 50-300 m	Vhanthaburi, Krabi
	Ardisia atrovirens	In evergreen forest	Krabi
	Ardisia alata	In evergreen forest; by streams, alt. 50-100 m	Phangnga, Ranong
	Ardisia palustris	In freshwater swamp forest at low altitude	Narathiwat
	Ardisia ionantha	In forest along streams, alt. 700 m	Chon Buri, Chanthaburi, Ranong
	Ardisia fulva var. ciliate	In savanna	Phuket, Satun
	Ardisia maehongsonia	Common in clearing; alt. 500-600 m	Mae Hong Son
	Ardisia peduncalata	In evergreen forest, at low altitudes	Surat Thani
	Ardisia gracillima	In bamboo forest; altitude ca 100 m	Chumphon
	Ardisia multipunctata	In evergreen forest; alt. 800 m	Trang, Pattani
	Ardisia subpilosa	In scrub at low altitudes	Krabi
	Ardisia furva	In evergreen forest; by streams and in moist places	Trang, Pattani
	Ardisia aprica	Growing on open ground, covering large areas; alt. 200 m	Khon Kaen, Chaiyaphum, Si Sa Ket
	Ardisia ficifolia	In evergreen forest by streams; alt. 250 m	Kanchanaburi
	Ardisia translucida	In evergreen forest; alt. 200-600 m	Ranong
	Ardisia corymbifera var. euryoides	In forest; alt. 1,000-1,600 m	Phitsanulok
	Ardisia confuse	In dry evergreen forest	Kanchanaburi
	Ardisia stipitata	Scattered in dry evergreen forest; alt. 200 m	Phitsanulok, Nong Khai
	Ardisia bractescens	In evergreen forest	Ranong, Chumphon
	Ardisia cordulata var. cordulata	In evergreen forest by streams, alt. 50-600 m	Yala, narathiwat
	Ardisia cordulata var. appressohirsuta	Unknown	Phuket

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
MYRSINACEAE (Cont)	*Ardisia fimbriata*	In evergreen forest; alt. ca 1,400 m	Kanchanaburi
	Ardisia curvistyla	In shady places along streams; alt. 400-900 m	Kanchanaburi
	Embelia sootepensis	In mixed forest; alt. ca 300 m	Chiang Mai
	Embelia impressa	In evergreen forest; alt. 1,250-1,350 m	Chiang Mai
	Embelia kerri	In evergreen forest; alt. 1,000-1,400 m	Nakhon Ratchasima
	Embelia grandifolia	In evergreen forest; alt. 100 m	Chanthaburi
	Maesa aryyrophylla	In dry evergreen forest; alt. 1,100-1,300 m	Chiang Mai
	Maesa glomerata	In evergreen forest; alt. 700-1,100 m	Chiang Mai
	Maesa lineolata	In bamboo forest	Kanchanaburi
	Maesa integrifolia	In evergreen forest, from sea level to 650 m	Chumphon, Ranong, Phuket, Krabi, Nakhon Si Thammarat, Trang, Satun, Narathiwat
APOCYNACEAE	*Alyxia thailandica*	In evergreen or drydipterocarp forest, 700-1,400 m	Nakhon Ratchasima, Nakhon Nayok
	Kopsia angustipetala	In dry evergreen forest at 200 m	Nong Khai
	Wrightia lanceolata	In dry rocky areas on limestone to 300 m	Prachuap Khirikhan
	Wrightia viridiflora	Linestone areas to 800 m	Kanchanaburi, Ratchaburi, Saraburi
	Ichnicarpus fulvus	Trailing in open sandy area or climbing in evergreen or deciduous forest. Sea level to 150 m	Chon Buri, Trat
	Ichnocorpus uliginosus	In low bushes in marshy area	Phitsanulok, Kamphaeng Phet
PRIMULACEAE	*Lysimachia oppositifolia*	In scrub jungle, ca 1,800 m	Chiang Mai
	Lysimachia pilosa	In evergreen forest, ca 1,500 m	Chiang Mai
	Lysimachaia garrettii	In evergreen forest; alt. 1,600-1,700 m	Chiang Mai
	Lysimachia remotifolra	In scrub, alt. ca 1,700 m	Chiang Mai
	Primula caulifera	Moist savanna, near edge of dry evergreen forest, alt. 800 m	Chaiyaphum
	Primula siamensis	In crevices of limestione rocks, alt.700-2,000m	Chiang Mai
	Primula intanoensis	On moist, humus rich ground in mossy forest; alt. 1,900-2,595 m	Chiang Mai
OLEACEAE	*Chionanthus sutepensis*	In lower montane forest up to 1,800	Chiang Mai
	Chionanthus decipiens	Evergreen forest; alt. ca 50-200 m	Ronong, Narathiwat
	Chionanthus velutinus	Mixed deciduous forest; alt. about 200 m	Khon Kaen, Nakhon Tatchasima
	Chionanthus eriorachis	Evergreen forest; alt. about 10 m	Prachuap Khirikhan
	Chionanthus amblirrhinus	Savanna on sandstone bedrock; alt. ca 130-550 m	Chiang Mai, Nakhon Phanom, Si Sa Ket, Ubon Ratchathani
	Chionanthus maxwellii	Primaty, mostly evergreen forest, near a stream on granitic bedrock; alt. 1,400 m	Chiang Mai
	Chionanthus sp. "A"	Evergreen forest on a sandstone hill; alt. 50 m	Ranong
	Jasminum calcicola	Evergreen forest on limestone hill from about 100 to 900 m alt.	Lampang, Kanchanaburi, Lop Buri, Narathiwat
	Jasminum siamense	Scrub, open dry bamboo forest and deciduous forest, often in limestion areas, from about 50 to 100 m alt.	Mae Hong Son, Loei, Ta, Chiang Mai, Lampamg, Uttaradir, Phrae, Nakhon Sawan, Nakhon Ratchasima, Uthai Thani, Kanchanburi, Prachuap Khirikhan

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
OLEACEAE (Cont.)	*Jusminum annamense* subsp. *kerri*	Open deciduous forest, at about 200 to 400 m alt.	Nong Khai, Sakon Nakhon, Nakhon Phanom, Mukda Han
	Jusminum perissanthum	Evergreen forest, 1,600-1,700 m alt.	Nan
	Jusminum stellipilum	Scrub, and the edge of evergreen forest, from 1.5-50 m alt.	Chumphon, Ranong
MYRISTICACEAR	*Horsfieldia amygdalina* var. *macrocarpa*	Understorey tree in mixed seasonal evergreen or deciduous hard wood forest. Granite bedrock; alt. 600-1,100 m	Chiang Mai, Lamphun
	Knema andamanica subsp. *peninsularus*	Primary and secondary evergreen forest; alt. 50-500 m	Nakhon Si Thammarat, Tramg
	Knema austrosiamensis	Evergreen forest; alt. 0-1,000 m	Kanchanaburi, Chanthaburi, Ranong, Nakhon Si Thammarat
	Knema conica	Evergreen and dry evergreen forest; alt. 0-900 m	Kanchanaburi
	Knema tenuinervia subsp. *kanburiensis*	Mixed deciduous forest; alt. 500-900 m	Kanchanaburi
MYRTACEAE	*Cleistocalyx khaoyaiensis*	Streams and waterfalls in evergreen forest; 600-800 m	Prachin Buri
	Cleistocalyx phengklaii	Bamboo forest; 250 m	Ratchaburi
	Syzygium aksornae	Streams. Evergreen forest; 100-200 m	Chumphon, Surat Thani
	Syzygium boisianum subsp. *longifolium*	Unknown	Pattani, Narathiwat
	Syzygium campanulatum var. campanulatum	Evergreen forest; 300-700 m	Songkhla, Pattani
	Syzygium campanulatum var. longistylum	Evergreen forest	Ronong
	Syzygium craibii	Evergreen forest	Yala
	Syzygium fuscescens	Hill slopes, evergreen forest 0-100 m	Ranong, Trang
	Syzygium gratum var. confertum	Tropical rain forest; 900-1,000 m	Tanong, Phangnga
	Syzygium hemsleyanum subsp.*pancinervium*	In evergreen forest	Narathiwat
	Syzygium ixoroides	Waterfall, disturbed evergreen forest; 400-500 m	Nakhon Si Thammarat
	Syzygium kerrii	In evergreen forest	Chanthaburi
	Syzygium laetum subsp. *juporum*	Mossy wet evergreen forst; 1,500-1,700 m	Nakhon Si Thammarat
	Syzygium laetum subsp. *sublaetum*	Evergreen ridge forest; 1,300 m	Ranong
	Syzygium lakshmakarae	Evergreen forest; 900 m	Loei
	Syzygium intrasirirakii	Evergreen forest	Narathiwat
	Syzygium prainanum subsp. minor	Evergreen forest; 900 m	Phagnga
	Syzygium putii	Evergreen forest and swamp ground at the foot of limestone hills, 50 m	Chumphon, Krabi, Satun
	Syzygium rigens	Evergreen forest, on peaks and ground; 800-1,000 m	Chumphom, Ronong, Surat Thani, Phagngna, Krabi, Yala
	Syzygium samarangense var. parviflorum	Evergreen forest; 900 m	Yala
	Syzygium thumra subsp. *punctifolium*	Evergreen forest; 100 m	Phangnga

Annex 8 Endemic dicotyledon species (Cont.)

Family	Scientific name	Habitat	Locality
MELASTOMATACEAE	*Anerincleistus pedunculatus*	Evergreen forest	Chumphon, Ranong, Surat Thani, Phangnga, Songkhla
	Phyllagathis siamensis	Along streams at alt. below 400 m	Suraburi, Nakhon Nayok
	Phyllagathis tuberose	Growing on rocks by a stream in evergreen forest. Only know from the type, which was collected at 700 m alt.	Phitsamylok
	Sonerila spectabilis	Unknown	Prachuap Khirikhan
	Sonerila urceolata	Dry evergreen forest in a ravine between 300 and 800 m alt.	Chanthaburi
STERCULIACEAE	*Firmiana kerrii*	Scattered on rock limestone ridges; alt. 900-1,800 m	Chiang Mai
	Pterospermum grandiflorum	In dry evergreen and moist upper mixed deciduous forest; alt. 500-1,100 m	Chiang Mai, Loei, Uthai Thani
	Pterospermum littorale var. *littorale*	In old clearing and mixed deciduous forest; alt. 100-1,000 m	Chiang Mai, Phisanulok, Loei, Manthaburi, Bangkok, Kanchanaburi, Prachuap Khirikhan, Chon Buri, Rayong, Trat, Ranong, Surat Thaini, Krabi, Nakhon Si Thammarat, Phatthalung, Yala
	Pterospermum littorale var. *venustrum*	In evergreen forest; alt. ca 200 m	Phitsanulok
	Reevesia pubescens var. *siamensis*	In old clearings along edge of evergreen forest; alt. 600-1,300 m	Loei, Nakhon Ratchasima, Kanchanaburi, Nakhon Nayok

Annex 9 *Ex situ* collection

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
BRDO	Exploration, Collection, Conservation and Rejuvenation of Rice Genetic Resources	Rice	24,369
BRDO	Exploration, Collection, Conservation and Rejuvenation of Maize Genetic Resources	Maize	101
BRDO	Exploration, Collection, Conservation and Rejuvenation of Sesame Genetic Resources	Sesame	231
BRDO	Exploration, Collection, Conservation and Rejuvenation of Jute Genetic Resources	Jute	47
BRDO	Exploration, Collection, Conservation and Rejuvenation of Soya bean Genetic Resources	Soya bean	2,230
BRDO	Exploration, Collection, Conservation and Rejuvenation of Ground nut Genetic Resources	Ground nut	1,750
BRDO	Exploration, Collection, Conservation and Rejuvenation of Cotton Genetic Resources	Cotton	150
BRDO	Exploration, Collection, Conservation and Rejuvenation of Mungbean Genetic Resources	Mungbean	446
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Okra	50
Srisaket Sericultural Research Center	Field genebank conservation of germplasm, Department of Agriculture	Kradung-nga	80
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Kradum thong	500
NongKhai Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Kradon	145
Ubon Ratchathani FCRC	Field genebank conservation of germplasm, Department of Agriculture	Kra thin narong	268
Pattani Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kra phor	200
Yala Technical and Production Resources Service Center;Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Krawan	550
Loei 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kritsana	1000
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kluai khai	1162
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Banana, Kluai namwa	2190
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kluai mai din	337
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Klui leb mue nang	500
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Kap hoi khraeng	500
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Chinese chive	5100
Burirum 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Jack fruit	500
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Jack friut	790

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Jack fruit	502
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Curcuma	1500
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kee lek	238
Chumpon Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kee lek	225
Nakhon Sri Thammarat Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Kee lek	141
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Kem Chaing Mai	2000
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Kem Pissanulok	500
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Khem india	200
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Cha plu	300
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tea	80000
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Tea	2000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tea	1000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tea	500
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tea	8000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tea	3000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tea	2000
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Torch ginger	2600
Narathiwat Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Torch ginger	1115
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Amazon lily	200
Office of Agricultural research and Development Region 6, Chanthaburi	Field genebank conservation of germplasm, Department of Agriculture	Prickly leaved elephant's foot	500
Chainat FCRC	Field genebank conservation of germplasm, Department of Agriculture	Ebony	125
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Sugar palm	1765
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Wine palm	400
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tho	250
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Tho	432

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Thong kwao	32
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Thong kwao	40
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Thong dok buap	30
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Thong lang	100
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Sour sop, Guanabana, Durian belanda	347
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Durian monthong	200
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Thian thong	200
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Thian king	60
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Golden dewdrop Pigeon-berry, Sky-flower	100
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Thamma raksa	500
Khao Ko Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Cherimoya, Custard apple	245
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Nectarine	363
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Blue-Hawaii	300
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Buai	250
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Buai	108
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Taro, Cocoyam	100
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Bora phet	100
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Asiatic pennywort	400
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Bua sawan	100
Pranakhon Sriayutthaya Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Lotus	100
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Trumpet flower	100
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Trumpet flower	500
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Four O'clock, Marvel of Peru	100

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Begonia	200
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Buk khontho	250
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Banksia	300
Kalasin Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Pradu	620
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Pradu	346
Nakhon Sri Thammarat Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Pradu	453
Mookdahan Technical and Production Resources Service Cente, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Pradu	731
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Pradu	147
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Palm	200
Surat Thani Oil Palm Research Center	Field genebank conservation of germplasm, Department of Agriculture	Oil palm	100
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Phaka krong	300
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Phaka krong	1000
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Morning glory	840
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Phak mek	100
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Phak wan	500
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Phak wan pa	200
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Taro,Cocoyam	4450
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Bamboo	125
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Bamboo	340
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Bamboo	387
Office of Agricultural research and Development Region 1, Chiang Mai	Field genebank conservation of germplasm, Department of Agriculture	Phai sang mon	100
Khao Ko Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phai tong	450
Burirum 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phai tong	1500

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Khao Ko Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phai tong	240
Loei 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phai wan muang loei	500
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Guava	103
Phrae Sericultural Research Center	Field genebank conservation of germplasm, Department of Agriculture	Sappan tree	170
Nakhon Sawan FCRC	Field genebank conservation of germplasm, Department of Agriculture	Cotton	300
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Vetiver,Khuskhus,Cuscus,Sevendara	35000
Trang HRC	Field genebank conservation of germplasm, Department of Agriculture	Faek hom	100
Loei 3 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Devil tree, White cheesewood, Blackboard tree, Devil's bark	85
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Chilli	100
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Chilli	9600
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Chilli	4800
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Pepper	100
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phlap	150
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Persimmon	352
Loei 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phlap fad	200
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Plum	394
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Betel pepper	100
Mookdahan Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Phayom	513
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Phayom	100
Surin RRC	Field genebank conservation of germplasm, Department of Agriculture	Siamese rosewood	96
Pattani Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Phantan	50
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Phut phitchaya	200
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Phut sam si	100

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Jujube	3441
Suratthani Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Phet sangkhat	100
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Fa thalai chon	270
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Fa thalai chon	100
Suratthani Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Fa thalai chon	100
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Beaugainvillea	500
Chainat FCRC	Field genebank conservation of germplasm, Department of Agriculture	Hog plum	118
Ubon Ratchathani FCRC	Field genebank conservation of germplasm, Department of Agriculture	Ma kok nam	56
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kok nam man	70
Office of Agricultural research and Development Region 3, Khonkaen	Field genebank conservation of germplasm, Department of Agriculture	Ebony tree	120
Loei 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kiang	200
Srisaket HRC	Field genebank conservation of germplasm, Department of Agriculture	Ma kiang	1136
Nongkhai HRC	Field genebank conservation of germplasm, Department of Agriculture	Ma kiang	1072
NongKhai Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kiang	252
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kiang	1230
Lampang Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kiang	960
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Indian date,Tamarind	166
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Indian date,Tamarind	125
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Indian date,Tamarind	149
Burirum 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kham priaw	1000
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Love apple, Wild tomato	100
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kha de mia	1000
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Ma kha de mia	300
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Ma kha de mia	430

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
NongKhai Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kha mong	469
Nongkhai HRC	Field genebank conservation of germplasm, Department of Agriculture	Beal fruit tree, Bengal quince, Bilak	300
NongKhai Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Beal fruit tree, Bengal quince, Bilak	1814
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Common lime	125
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Manao tahiti	337
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Marianplum, Plum mango	120
Nakhon Sri Thammarat Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Coconut	303
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Coconut	100
Suratthani Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Coconut	1900
Srisaket Sericultural Research Center	Field genebank conservation of germplasm, Department of Agriculture	Coconut	100
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Carambola	740
Ubon Ratchathani Field Crops Research Center	Field genebank conservation of germplasm, Department of Agriculture	Ma phok	132
Loei 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mafai pa	160
Chumpon Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango tree	150
Burirum 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango tree	3000
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango tree	1228
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango tree	221
Office of Agricultural research and Development Region 3, Khon kaen	Field genebank conservation of germplasm, Department of Agriculture	Mango tree	224
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Mango tree	600
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang kaeo	397
Kanchanaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango	573
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang Khiao sa woei	152
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang chok anan	328

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang nam dokmai sithong	369
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang maha chanok	221
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang raet	51
Sukothai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Mango, Mamuang nang klangwan	42
Phetchaburi Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Cashew nut	270
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Papaya, Pawpaw, Tree melon	500
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Jasmine	100
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Mali la	200
Chumphon Horticultural Research Center	Field genebank conservation of germplasm, Department of Agriculture	Mali la	150
Pichit HRC	Field genebank conservation of germplasm, Department of Agriculture	Sweet potato	2061
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Ma kamlung	200
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Mok luang	100
Chainat FCRC	Field genebank conservation of germplasm, Department of Agriculture	Yo pa	115
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Para rubber	233
Phuket Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Para rubber	5000
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Upas tree	100
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Red gum	108
Nong Kai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Red gum	476
Krabi (Rice) Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Rongthao nari khao satun	949
Krabi (Rice) Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Rongthao nari trang	624
Krabi (Rice) Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Rongthao nari lueang krabi	4859
Krabi (Rice) Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Rongthao nari lueang trang	624
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Rang chuet	100

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Chaiyapoom Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Golden shower, Indian laburnum, Pudding-pine tree	254
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Bastard cardamom, Tavoy cardamom	400
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Bastard cardamom, Tavoy cardamom	1000
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Ruesi phasom laeo	500
Surat Thani Oil Palm Research Center	Field genebank conservation of germplasm, Department of Agriculture	Longkong	204
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Rangngoen	200
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Longan	250
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Litchi	750
Loei 2 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Litchi	297
Chiang Rai HRC	Field genebank conservation of germplasm, Department of Agriculture	Litchi	192
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Lep khrut	100
Chainat FCRC	Field genebank conservation of germplasm, Department of Agriculture	Lep yiao	130
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Lo khlot	250
Chumphon HRC	Field genebank conservation of germplasm, Department of Agriculture	Vanilla	434
Suratthani Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Wan kab hoy	200
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Wan jaidum	100
Phrae HRC	Field genebank conservation of germplasm, Department of Agriculture	Wan chak motluk	50
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Wan thorani san	30
Suratthani Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Wan nang chi	100
Sakol Nakhon Technical and Production Resources Service Center, Sericulture Branch	Field genebank conservation of germplasm, Department of Agriculture	Wan fai	47
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Wan mahakan	50
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Wan rang chueat	100
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Wan sao long	500
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Wan hua muang	200

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Star cactus, Aloe, Aloin, Jafferabad, Barbados	100
Sakol Nakhon Technical and Production Resources Service Center, Sericulture Branch	Field genebank conservation of germplasm, Department of Agriculture	Star cactus, Aloe, Aloin, Jafferabad, Barbados	86
Sakol Nakhon Technical and Production Resources Service Center, Field Crops Branch	Field genebank conservation of germplasm, Department of Agriculture	Leopard lily	100
Suratthani Rubber Research Center	Field genebank conservation of germplasm, Department of Agriculture	Leopard lily	50
Yala Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Wan hok long	500
Tak 1 Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Vanilla	3200
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Vanilla	100
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Waen kaeo	100
Chumpon Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Si trang	66
Chiangmai Royal Agricultural Research Center, Horticultural Branch	Field genebank conservation of germplasm, Department of Agriculture	Suphachok	427
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Setthi ruean nok	100
Chanthaburi HRC	Field genebank conservation of germplasm, Department of Agriculture	Setthi ruean nai	300
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Harunoka strawberry	1000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Japan strawberry	1000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Seller strawberry	1000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Tiog strawberry	1000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Toyonoka strawberry	1000
Chiang Rai Technical and Production Resources Service Center	Field genebank conservation of germplasm, Department of Agriculture	Turgid strawberry	1000
DNP	*Ex situ* Conservation of Forest Genetic Resource in Thailand	*Pterocarpus macrocapus*, *Xyllia kerii*, *Shorea* spp.,	900

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
DNP	Markers (Measuring gene diversity of forest tree species in Thailand by means of isoenzyme gene and DNA markers)	*Tectona grandis, Acacia auriculiformis*, Mangroves spp., Dipterocarpaceae spp., Rattan spp., *Bamboo* spp., *Melia azedarach, Aquilaria crassna, Acacia mangium, Eucalyptus camaldulensis, Anthocephalus chinensis, Alstonia scholaris, Xylia xylocarpa, Afzelia xylocarpa, Hopea odorata, Toona ciliata, Dalbergia oliveri, Chukrasia velutina*	
DNP	Evaluation of the genetic resources of *Tectona grandis* (Linn.) using molecular markers	*Tectona grandis*	
DNP	Survey of bamboo species for the establishment of species and clone bank and genetic variation study	*Bamboosa bambos* Wild, *Cephalostachyum pergracile* Munro, *B. blumeana* Schult., *Dendrocalamus brandisii* Kurz, *D. membrenaceus* Munro, *D. strictus* Nees, *Gigantochloa albociliata* Munro, *Thyrsostachys siamesis*	
DNP	Evalution of the status of genetic resource and mating systems of forest trees and plant in forest conservation areas by molecular markers for sustainable conservation and utilization	*Meliantha suavis*, Medicinal plant, *Tacca integrifolia*, Orchidaceae, *Vatia diospyroides, Borassus flabellifer*, *Parkia speciosa*	
DNP	Survey and vegetative propagation of rare and endangered plant species and economic forest tree species by means of biotechnology	Rare and endangered plant species, Economic Forest trees	
DNP	The integration of biodiversity management of forest and wildlife for conservation and sustainable utilization	*Pterocarpus macrocapus*, *Shorea* spp., *Tectona grandis, Acacia auriculiformis*, Mangroves spp., Dipterocarpaceae spp., Rattan spp., Bamboo spp., *Melia azedarach, Aquilaria crassna, Acacia mangium, Eucalyptus camaldulensis, Anthocephalus chinensis, Alstonia scholaris, Xylia xylocarpa, Afzelia xylocarpa, Hopea odorata, Toona ciliata, Dalbergia oliveri, Chukrasia velutina, Tectona grandis, Bamboosa bambos* Wild, *Cephalostachyum pergracile* Munro, *B. blumeana* Schult., *Dendrocalamus brandisii* Kurz, *D. membrenaceus* Munro, *D. strictus* Nees, *Gigantochloa albociliata* Munro, *Thyrsostachys siamesis, Meliantha suavis*, Medicinal plant, *Tacca integrifolia, Orchidaceae, Vatia diospyroides*, *Borassus flabellifer*, *Parkia speciosa*, Rare and endangered plant species, economic forest trees	

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
FCRI	Conservation and utilization of sesame genetic resources (Survey, collection, evaluation and database management)	Sesame	390
FCRI	Conservation and utilization of peanut genetic resources (Survey, collection, evaluation and database management)	Peanut, groundnut	2030
FCRI	Conservation and utilization of ramie genetic resources (Survey, collection, evaluation and database management)	Ramie	72
FCRI	Conservation and utilization of pigeon pea genetic resources (Survey, collection, evaluation and database management)	Pigeon pea	118
FCRI	Conservation and utilization of safflower genetic resources (Survey, collection, evaluation and database management)	Safflower	30
FCRI	Conservation and utilization of wild sugarcane genetic resources (Survey, collection, evaluation and database management)	Wild sugarcane	640
FCRI	Conservation and utilization of sugarcane genetic resources (Survey, collection, evaluation and database management)	Sugarcane	453
FCRI	Conservation and utilization of cassava genetic resources (Survey, collection, evaluation and database management)	Cassava	609
FCRI	Conservation and utilization of soybean genetic resources (Survey, collection, evaluation and database management)	Soya, soybean	1510
FCRI	Conservation and utilization of mulberry paper genetic resources (Survey, collection, evaluation and database management)	Paper mulberry	220
FCRI	Conservation and utilization of cotton genetic resources (Survey, collection, evaluation and database management)	Cotton	385
FCRI	Conservation and utilization of maize genetic resources (Survey, collection, evaluation and database management)	Corn, Maize	1036
FCRI	Conservation and utilization of mungbean and blackgram genetic resources	Mungbean	2250
FCRI	Conservation and utilization of specialty corns genetic resources (Survey, collection, evaluation and database management)	Specialty Corn	214
FCRI	Conservation and utilization of castor genetic resources (Survey, collection, evaluation and database management)	Castor	147
FCRI	Conservation and utilization of cowpea genetic resources (Survey, collection, evaluation and database management)	Cowpea	85
FCRI	Conservation and utilization of mungbean and blackgram genetic resources	Black gram	
FCRI	Conservation and utilization of silkworm genetic resources (Survey, collection, evaluation and database management)	Silkworm	
FCRI	Conservation and utilization of mulberry genetic resources (Survey, collection, evaluation and database management)	Mulberry	
FCRI	Conservation and utilization of Roselle genetic resources (Survey, collection, evaluation and database management)	Cuban kenaf	120
FCRI	Conservation and utilization of Roselle genetic resources (Survey, collection, evaluation and database management)	Jute	100
FCRI	Conservation and utilization of Roselle genetic resources (Survey, collection, evaluation and database management)	Jute	60
FCRI	Conservation and utilization of Roselle genetic resources (Survey, collection, evaluation and database management)	Roselle	200
HRI	Germplasm collection and study on tropical fruit species biodiversity in Thailand (*Durio* spp.)	Durian	287
HRI	Conservation and use of durian hybrid and native rambutan diversity	Durian	2510

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
HRI	Germplasm collection and conservation of Mangosteen and Rambutan hybrids	Mangosteen	10
HRI	Germplasm collection and conservation of Longan	Longan	24
HRI	Germplasm collection, conservation and use of Longan	Longan	23
HRI	Germplasm collection and study on Lansium varieties	Langsad	10
HRI	Germplasm collection and conservation of native Lansium and Rambutan	Mangosteen	181
HRI	*In situ* and greenhouse germplasm conservation of *Citrus* spp.	Orange, Mandarin	79
HRI	Germplasm collection and study on *Citrus* spp.	Orange, Mandarin	33
HRI	Germplasm conservation and study on *Citrus* spp. in Thailand and International country	Orange, Mandarin	79
HRI	Conservation and create germplasm of *Citrus* spp.	Orange, Mandarin	64
HRI	Germplasm collection, conservation and study on morphology of Pomelo	Pomelo	115
HRI	Germplasm collection and conservation of Rambutan hybrids and Longong	Rambutan	
HRI	Germplasm collection, conservation and selection of Torch Ginger for commercial	Torch ginger	163
HRI	Germplasm collection and conservation of ornamental plants (*Curcuma* spp.)	Curcuma	96
HRI	Germplasm collection and study on Orchidaceae (*Dendrobium* hybrids and *Vanda* hybrids) in Thailand		187
HRI	Germplasm collection and conservation of Torch Ginger	Torch ginger	86
HRI	Germplasm conservation of Litchi	Litchi	38
HRI	Surveying, collection, characterization and use of Litchi germplasm	Litchi	34
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Peach	7
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Apricot	9
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Pear	9
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Persimmon	13
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Plum	7
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Nectarine	6
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Peakan	10
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Passion fruit	6
HRI	Germplasm collection and conservation of fruit plants (winter region and others)	Olive	6
HRI	Collection and create germplasm of native fruit plants	Wild Olive	1
HRI	Collection and create germplasm of native fruit plants	Water Olive	1
HRI	Collection and create germplasm of native fruit plants	Sweet Malord	1
HRI	Collection and create germplasm of native fruit plants	Saor Malord	1
HRI	Collection and create germplasm of native fruit plants	Lookwa	1
HRI	Collection and create germplasm of native fruit plants	Wild Mafai	1
HRI	Collection and create germplasm of native fruit plants	Makamtes	1
HRI	Collection and create germplasm of native fruit plants	Chinese Mafai	1
HRI	Collection and create germplasm of native fruit plants	Marianplum	1
HRI	Collection and create germplasm of native fruit plants	Lookchid (Matao)	1
HRI	Collection and create germplasm of native fruit plants	Mator	1
HRI	Collection and create germplasm of native fruit plants	Makiang	1
HRI	Collection and create germplasm of native fruit plants	Starfruit	1
HRI	Collection and create germplasm of native fruit plants	Matoom	1

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
HRI	Collection and create germplasm of native fruit plants	Wild durian	1
HRI	Collection and create germplasm of native fruit plants	Makorsaen	1
HRI	Collection and create germplasm of native fruit plants	Maguayrusi	1
HRI	*In situ* and field genebank conservation of plum mango	Marianpkum	1
HRI	Germplasm collection and study on native fruit plants	Santol	1
HRI	Germplasm collection and study on native fruit plants	Korkao	1
HRI	Germplasm collection and study on native fruit plants	Jackfruit	1
HRI	Germplasm collection and study on native fruit plants	Korlan	1
HRI	Germplasm collection and study on native fruit plants	Jackfruit	1
HRI	Germplasm collection and study on native fruit plants	Champooling	1
HRI	Germplasm collection and study on native fruit plants	Roseapple	1
HRI	Germplasm collection and study on native fruit plants	Chamuang	1
HRI	Germplasm collection and study on native fruit plants	Takobe	1
HRI	Germplasm collection and study on native fruit plants	Talingping	1
HRI	Germplasm collection and study on native fruit plants	Pomegrannate	1
HRI	Germplasm collection and study on native fruit plants	Wild Durian	1
HRI	Germplasm collection and study on native fruit plants	Castard apple	1
HRI	Germplasm collection and study on native fruit plants	Noinong	1
HRI	Germplasm collection and study on native fruit plants	Nian	1
HRI	Germplasm collection and study on native fruit plants	Marong Jute	1
HRI	Germplasm collection and study on native fruit plants	Guava	1
HRI	Germplasm collection and study on native fruit plants	Phawa	1
HRI	Germplasm collection and study on native fruit plants	Jujube	1
HRI	Germplasm collection and study on native fruit plants	Olive	1
HRI	Germplasm collection and study on native fruit plants	Makampom	1
HRI	Germplasm collection and study on native fruit plants	Maton	1
HRI	Germplasm collection and study on native fruit plants	Lime	2
HRI	Germplasm collection and study on native fruit plants	Marianplum	1
HRI	Germplasm collection and study on native fruit plants	Maping	1
HRI	Germplasm collection and study on native fruit plants	Mapood	1
HRI	Germplasm collection and study on native fruit plants	Mapraew	1
HRI	Germplasm collection and study on native fruit plants	Starfruit	1
HRI	Germplasm collection and study on native fruit plants	Yellow Starfruit	1
HRI	Germplasm collection and study on native fruit plants	Lianthong Starfruit	1
HRI	Germplasm collection and study on native fruit plants	Crow Starfruit	1
HRI	Germplasm collection and study on native fruit plants	Local Starfruit	1
HRI	Germplasm collection and study on native fruit plants	Mamuangkuay	1
HRI	Germplasm collection and study on native fruit plants	Mamuangkan	1
HRI	Germplasm collection and study on native fruit plants	Mamuangtawai	1
HRI	Germplasm collection and study on native fruit plants	Wild Mango	1
HRI	Germplasm collection and study on native fruit plants	Mamuangpakborg	1
HRI	Germplasm collection and study on native fruit plants	Mamuangmood	1
HRI	Germplasm collection and study on native fruit plants	Mango	1
HRI	Germplasm collection and study on native fruit plants	Mamood	1
HRI	Germplasm collection and study on native fruit plants	Sapodilla	1
HRI	Germplasm collection and study on native fruit plants	Litchi	1

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
HRI	Germplasm collection and study on native fruit plants	Salac	1
HRI	Germplasm collection and study on native fruit plants	Breadfruit	1
HRI	Germplasm collection and study on native fruit plants	Annona	1
HRI	Germplasm collection and study on native fruit plants	Artocapus	1
HRI	Germplasm collection and study on native fruit plants	Baccaurea	1
HRI	Germplasm collection and study on native fruit plants	Cararium	1
HRI	Germplasm collection and study on native fruit plants	Chico-Mamey	1
HRI	Germplasm collection and study on native fruit plants	Diospyros	1
HRI	Germplasm collection and study on native fruit plants	Pilinut	1
HRI	Germplasm collection and study on native fruit plants	Syaygium	1
HRI	Germplasm collection and study on native fruit plants	Terminalia	1
HRI	Germplasm collection and study on native fruit plants	Zapote	1
HRI	Germplasm collection and study on fruit plants (Banana, Mango, Plum mango, Sapodilla, Jujube and Rambi)	Marianplum	15
HRI	Germplasm collection and study on fruit plants (Banana, Mango, Plum mango, Sapodilla, Jujube and Rambi)	Sapodilla	9
HRI	Surveying germplasm and study on morphology of Banana	Banana	3
HRI	Germplasm collection and conservation of Guava, Jackfruit and Jujube	Jackfruit	17
HRI	Germplasm collection and conservation of Guava, Jackfruit and Jujube	Jujube	6
HRI	Germplasm collection and study on Mango	Mango	98
HRI	Germplasm collection and conservation of Sapodilla, Sour Tamarind and Mango	Sapodilla	7
HRI	Germplasm collection and conservation of Sapodilla, Sour Tamarind and Mango	Tamarind	4
HRI	Germplasm collection and conservation of Sapodilla, Sour Tamarind and Mango	Mango	144
HRI	Germplasm collection and study on Tea	Tea	34
HRI	Germplasm conservation, characterization, evaluation and study on morphology of Pineapple	Pineapple	38
HRI	Germplasm collection and study on Coffee (Arabica)	Coffee	24
HRI	Germplasm collection and study on Jasmine	Jasmin	1
HRI	Germplasm conservation, collection and study on Scent wood in Northern of Thailand	Ginger	1
HRI	Germplasm conservation, collection and study on Scent wood in Northern of Thailand	Citronella	1
HRI	Germplasm conservation, collection and study on Scent wood in Northern of Thailand	Pandal leave	1
HRI	Germplasm collection and conservation of Ornamental flowers (Thai flowers and scent flowers)	Honey suckle	1
HRI	Germplasm collection and conservation of Ornamental flowers (Thai flowers and scent flowers)	Devili tree	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Jackfruit	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Anona	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Guava	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Tamarine	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Marianplum	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Coconut	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Papaya	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Bamboo	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Yard long bean	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Sword bean	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Cowpea	1

Annex 9 *Ex situ* collection (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Wing bean	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Morning glory	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Pumpkin	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Sweet potato	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Banana	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Pandal leave	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Pigeon pea	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Roselle	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Galangal	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Ginger	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Perilla	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Lemongrass	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Conyacky	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Coriander	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Dill	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Taro	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Chilli	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Chilli	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Tomato	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Egg plant	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Mint basil	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Peppermint	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Shallot	1
HRI	Germplasm collection and study on native vegetable in northern of Thailand	Sweet basil	1
HRI	Germplasm collection and conservation of Asparagus and Bamboo	Asparagus	12
HRI	Germplasm collection and conservation of Asparagus and Bamboo	Bamboo	16
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Bamboo	34
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Egg plant	4
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Chilli	30
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Morning glory	29
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Taro	450
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Sweet potato	78
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Sweet potato	96
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Sweet potato	50
HRI	*In situ* and field genebank conservation of Bamboo, Eggplant, Spur Chilli, Chinese chive, Water Convolvulus, Taro, Sweet potato and Ratten	Sweet potato	226
HRI	Conservation and use of durian hybrid and native rambutan diversity	Rambutan	
HRI	Germplasm collection and conservation of Mangosteen and Rambutan hybrids	Rambutan	8

Annex 10 Number of accessions stored under the specified storage

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions in short-term seed storage	Number of accessions in medium-term seed storage	Number of accessions in long-term seed storage	Number of accessions stored in field genebank	Number of accessions stored *in vitro*
BRDO (S-216-10)	Exploration, collection, conservation and rejuvenation of rice genetic resources	Rice		24000	24000		2
FCRI (S-216-3)	Conservation and utilization of sesame genetic resources (survey, collection, evaluation and database management)	Sesame	100		390		
FCRI (S-216-3)	Conservation and utilization of ramie genetic resources (survey, collection, evaluation and database management)	Ramie				36	
FCRI (S-216-3)	Conservation and utilization of pigeon pea genetic resources (survey, collection, evaluation and database management)	Pigeon pea	118				
FCRI (S-216-3)	Conservation and utilization of safflower genetic resources (survey, collection, evaluation and database management)	Safflower		30			
FCRI (S-216-3)	Conservation and utilization of wild sugarcane genetic resources (survey, collection, evaluation and database management)	Wild sugarcane				640	
FCRI (S-216-3)	Conservation and utilization of Roselle genetic resources (survey, collection, evaluation and database management)	Roselle		200			
FCRI (S-216-3)	Conservation and utilization of jute genetic resources (survey, collection, evaluation and database management)	Jute		60			
FCRI (S-216-3)	Conservation and utilization of sorghum genetic resources (survey, collection, evaluation and database management)	Sorghum		100			
FCRI (S-216-3)	Conservation and utilization of sugarcane genetic resources (survey, collection, evaluation and database management)	Sugarcane				453	

Annex 10 Number of accessions stored under the specified storage (Cont.)

Stakeholder	Name of *ex situ* collection	Name of crop	Number of accessions in short-term seed storage	Number of accessions in medium-term seed storage	Number of accessions in long-term seed storage	Number of accessions stored in field genebank	Number of accessions stored *in vitro*
FCRI (S-216-3)	Conservation and utilization of cassava genetic resources (survey, collection, evaluation and database management)	Cassava				555	609
FCRI (S-216-3)	Conservation and utilization of soybean genetic resources (survey, collection, evaluation and database management)	Soybean, soya	277		1510		
FCRI (S-216-3)	Conservation and utilization of mulberry paper genetic resources (survey, collection, evaluation and database management)	Paper mulberry				220	
FCRI (S-216-3)	Conservation and utilization of cotton genetic resources (survey, collection, evaluation and database management)	Cotton		385			
FCRI (S-216-3)	Conservation and utilization of maize genetic resources (survey, collection, evaluation and database management)	Maize		1036			
FCRI (S-216-3)	Conservation and utilization of mungbean genetic resources (survey, collection, evaluation and database management)	Mungbean		2250			
FCRI (S-216-3)	Conservation and utilization of specialty corns genetic resources (survey, collection, evaluation and database management)	Specialty corn		214			
FCRI (S-216-3)	Conservation and utilization of castor genetic resources (survey, collection, evaluation and database management)	Castor			147		
FCRI (S-216-3)	Conservation and utilization of cowpea genetic resources (survey, collection, evaluation and database management)	Cowpea			85		

Annex 11 Percentage of accessions presently characterized and/or evaluated for various types of descriptors

Stakeholder	Name of *ex situ* collection	Name of crop/crop group	% of accessions characterized for morphological traits	% of accessions characterized based on molecular markers	% of accessions evaluated for agronomic traits	% of accessions evaluated for biochemical traits	% of accessions evaluated for abiotic stresses	% of accessions evaluated for biotic stresses
BRDO (S-216-10)	Conservation and Rejuvenation of Rice Genetic Resources	Rice	70	0	60	0	10	20
Supplement Farmer Supporting Group (S-216-25)	Collection of Local Rice Varieties	Rice						
FCRI (S-216-3)	Conservation and utilization of sesame genetic resources (Survey, collection, evaluation and database management)	Sesame	100	0	100	50	20	20
FCRI (S-216-3)	Conservation and utilization of peanut genetic resources (Survey, collection, evaluation and database management)	Peanut, Groundnut	100	0	100	0	0	0
FCRI (S-216-3)	Conservation and utilization of ramie genetic resources (Survey, collection, evaluation and database management)	Ramie	100	0	100	0	0	0
FCRI (S-216-3)	Conservation and utilization of wild sugarcane genetic resources (Survey, collection, evaluation and database management)	Wild sugarcane	70	50	70	0	0	0
FCRI (S-216-3)	Conservation and utilization of sugarcane genetic resources (Survey, collection, evaluation and database management)	Sugarcane	80	2	80	20	0	0

Annex 11 **Percentage of accessions presently characterized and/or evaluated for various types of descriptors (Cont.)**

Stakeholder	Name of *ex situ* collection	Name of crop/crop group	% of accessions characterized for morphological traits	% of accessions characterized based on molecular markers	% of accessions evaluated for agronomic traits	% of accessions evaluated for biochemical traits	% of accessions evaluated for abiotic stresses	% of accessions evaluated for biotic stresses
FCRI (S-216-3)	Conservation and utilization of cassava genetic resources (Survey, collection, evaluation and database management)	Cassava	50	25	50	20	20	20
FCRI (S-216-3)	Conservation and utilization of soybean genetic resources (Survey, collection, evaluation and database management)	Soybean, Soya	70	5	70	50	50	50
FCRI (S-216-3)	Conservation and utilization of maize genetic resources (Survey, collection, evaluation and database management)	Corn, Maize	50	0	50	20	50	30
FCRI (S-216-3)	Conservation and utilization of mungbean genetic resources (Survey, collection, evaluation and database management)	Mungbean	100	2	100	60	60	60
FCRI (S-216-3)	Conservation and utilization of specialty corns genetic resources (Survey, collection, evaluation and database management)	Specialty corn	70	0	70	50	50	50
FCRI (S-216-3)	Conservation and utilization of castor genetic resources (Survey, collection, evaluation and database management)	Castor	100	0	100	100	50	100
FCRI (S-216-3)	Conservation and utilization of pigeon pea genetic resources (Survey, collection, evaluation and database management)	Pigeonpea	100	0	100	40	0	0

Annex 12 Research on breeding programme

Name of programme/ project/activity	Trait(s) 120/characteristic(s) addressed	Agroecological zone(s) /Farming system(s) (the improvement applies to	Estimated importance of the improvement in terms of food security for the specified agroecological zone/farming system	Germplasm source(s)	Participatory breeding involved farmers in
Research and Development for Increasing Production of 'Sao Hai' Rice Variety	Sensitive to photoperiod, tall, harvesting date is early December.	Sensitive to photoperiod, local rice variety planted in rainfed and irrigated lowlands of central plain.	Medium	National genebank	Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plants, high yield and moderately resistant to brown spot; plant all the year in central plain.	Irrigated lowland areas in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield, and resistant to green leafhopper.	Planted all the year in irrigated areas.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to bacterial leaf blight, moderately resistant to blast, moderately tolerant to acid soil, be able to plant in upland areas, planted all the year in central plain.	Irrigated lowland areas in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countryies	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents

Annex 12 Research on breeding programme (Cont.)

Name of programme/ project/activity	Trait(s) 120/characteristic(s) addressed	Agroecological zone(s) /Farming system(s) (the improvement applies to	Estimated importance of the improvement in terms of food security for the specified agroecological zone/farming system	Germplasm source(s)	Participatory breeding involved farmers in
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to developing non-sensitive to photoperiod rice varieties with short plant, high yield and moderately resistant to brown planthopper, moderately resistant to rice tungro disease, leaf spot and gall midge resistant to ragged stunt in the field, planting all the year in central plai, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to moderately resistant to blast and leaf spot, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to bacterial leaf blight and ragged stunt in the field, resistant to brown planthopper, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents

Annex 12 Research on breeding programme (Cont.)

Name of programme/ project/activity	Trait(s) 120/characteristic(s) addressed	Agroecological zone(s) /Farming system(s) (the improvement applies to	Estimated importance of the improvement in terms of food security for the specified agroecological zone/farming system	Germplasm source(s)	Participatory breeding involved farmers in
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to , planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregating populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to early maturity, resistant to bacterial leaf blight and ragged stunt moderately resistant to brown planthopper and stem borers, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network;CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to green leafhopper, whitebacked planthopper, blast and bacterial leaf blight, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to brown planthopper, blast. Bacterial leaf blight, ragged stunt and rice tungro disease in the field, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents

Annex 12 Research on breeding programme (Cont.)

Name of programme/ project/activity	Trait(s) 120/characteristic(s) addressed	Agroecological zone(s) /Farming system(s) (the improvement applies to	Estimated importance of the improvement in terms of food security for the specified agroecological zone/farming system	Germplasm source(s)	Participatory breeding involved farmers in
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to brown planthopper, whitebacked planthopper, ragged stunt and blast, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to brown planthopper, whitebacked planthopper, blast, ragged stunt and rice tungro disease, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to bown planthopper, ragged stunt, rice tungro disease, blast and bacterial leaf blight, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plants, high yield and moderately resistant to moderately resistant to blast, bacterial leaf blight and whitebacked planthopper. Semidwarf aromatic rice, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network;CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents

Annex 12 Research on breeding programme (Cont.)

Name of programme/ project/activity	Trait(s) 120/characteristic(s) addressed	Agroecological zone(s) /Farming system(s) (the improvement applies to	Estimated importance of the improvement in terms of food security for the specified agroecological zone/farming system	Germplasm source(s)	Participatory breeding involved farmers in
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to moderalately resistant to bacterial leaf blight and whitebacked lanthopper. Semidwarf aromatic rice, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to brown planthopper, whitebacked planthopper, blast and bacterial leaf blight. Semidwarf aromatic rice, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network;CGIAR genebank; Public organization from developed countries;Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to moderately resistant to brown planthopper rather than PTT1, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to blast, brown planthopper and green leafhopper, only at Prachin Buri Province.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents

Annex 12 Research on breeding programme (Cont.)

Name of programme/ project/activity	Trait(s) 120/characteristic(s) addressed	Agroecological zone(s) /Farming system(s) (the improvement applies to	Estimated importance of the improvement in terms of food security for the specified agroecological zone/farming system	Germplasm source(s)	Participatory breeding involved farmers in
Research and Development of Irrigated Lowland Rice in the Central Region	Developing rice varieties non-sensitive to photoperiod, with short plant, high yield and moderately resistant to brown planthopper, moderately resistant to whitebacked planthopper and green leaf hopper, planting all the year in central plain.	Irrigated lowland area in central plain.	High	National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Public organization from developing countries	Setting breeding priorities; Selection from fixed lines or finished varieties (participatory varietal selection); Selection from segregated populations; Making crosses and/or determining parents
Irrigated Rice Improvement in the Lower - Northern Region	yield	lower Northern area	Medium	Local genebank; National genebank	Setting breeding priorities
Irrigated Rice Improvement in the Upper - Northern Region	yield	Upper Northern area	Medium	Local genebank; National genebank	Setting breeding priorities
Floating Rice Varietal Improvement	high yield, resistance to major diseases	Flood prone area	Medium	National genebank	Setting breeding priorities
Breeding programme for high yield and quality in sesame	Sesame Breeding Programme for high yielding Sesame Breeding Programme for high oil Sesame Breeding Programme for high lignans Sesame Breeding Programme for disease resistance Sesame Breeding Programme for drought tolerance Sesame Breeding Programme for nonphotosensitive	Cropping system before of after rice in the paddy field Cropping system before or after major economic crops such as maize in the uplands	High	Local genebank; National genebank; Regional/International network; CGIAR genebank; Public organization from developed countries; Private sector	Segregated from fixed lines or finished varieties (participatory varietal selection)

Annex 13 Top three popular local rice varieties in each province of Thailand

Province	Variety name
Angthong	Pamah Haek Kuk, Hawm Tung, Chom Tung
Bangkok	Khao Luang, Leuang Kwai Lah, Pahn Tawng
Chachoengsao	Khao tah Reua, Kwan Chai, Leuang Pratew
Chai Nat	Hawm Rai, Khao Jek, Hawm Gulahb
Chaiyaphum	Khao' Gam, Hawn Dong, E-tok
Chanthaburi	Leuang Awn, Khao Lon Yung, Khao Pahk Maw
Chiang Mai	Muey Nawng, Beu Koo Dai, Beu Po Lo
Chiang Rai	Daw Hahng Leeb, Blay Lia, Blay Chai
Chon Buri	Leuang Pratew, Kwan Chai, Leuang Bangbai
Chumphon	Nahng Pa-yah 132, Chiang Patthalung (improved local var.)
Kalasin	Rahk Pai, E-daw Khao, Pawng Aew
Kamphaeng Phet	Khao Dawk Mali 105 (improved local var.)
Kanchana Buri	Nong Ri, Khao Lom, Leuang Pratew
Khon Kaen	Hawm Pae, Gahb Yahng, Gaen Daeng
Krabi	Lebnok, Hawm Jan, Tam Me Rai
Lampang	Ja Naw Nae, Muey Nawng, Khao' Luang
Lamphum	Muey Nawng, Khao' Leum Mah, Khao' Sew
Loci	Sew Gliang, Plah Sew Noi, Plah Sew Yai
Lop Buri	Leuang Pratew, Leuang Pahn Tawng, Leuang Awn
Maha Sarakham	Daw Sahyan, Niaw Khao, Niaw Dam
Mae Hong Son	Seu Go Ma, Pl Lo, Ah Sah Seu Ma
Mukdahan	E-meud, Mae Pueng, Hawm Nahng Nuan
Nakhn Nayok	Leuang A-mawn, Khao Long, Khao Tah Haeng
Nakhom Ratchasima	Gam, Niaw Pawng Aew
Nakhon Pathom	Puang Ngern, Puang Tawng, Leuang Auyr
Nakhon Phanom	Khiaw Ngoo, Gahb Yalung, Mahk Yom
Nakhon Sawan	Hawm Bai-tuey, Khao Kaset, C85 (improved var.)
Nakhon Si Thammarat	Leb, Nok, Si Rak, Chaw Pli Dam
Nan	Khao' Nawn, Khao' Mawk, Khao' Kun
Narathiwat	Yeu Lab Pae, Gu Ning, Hawm Gra-dang-nga
Nong Khai	Rahk Pai, E-leuang
Pathum Thani	Khao Dawk Mali 105 (improved local var.)

Annex 13 Top three popular local rice varieties in each province of Thailand (Cont.)

Province	Variety name
Pattani	Chaw Lung, Maw Arun, Ma Jah Noo
Patthalung	Chaw Bow, Song Yod, Hawm Jan
Payao	Fahng Loi, Daw Sob Pow, Pah Werng
Phangnga	Khao Dawk Mali 105 (improved local var.)
Phet Chabun	Auang tawng, Khao Gaw Diew
Phet Buri	Leuang Awn, Khao Gantang
Phichit	Luang Pratahn Bow, Leuang Awn, Khao Gaw Diaw
Phitsanulok	Khao Chagaht, Puang Tawng, Saeng Muek
Phra Nakhon Si Ayutthaya	Puang Tawng Nak, Khao Lamyai, Khao Mali
Phrae	Khao' Hao, Khao' Gam, Khao' Sew
Phuket	Leb Nok, Mae Bui
Prachin Buri	Khiaw Yai, Plai Ngahm Prachin Buri, Khao Luang
Ranong	Khao' Khao
Rayong	Khao Mahk Khaek, Nalng Samer, Khao Setti
Ratchaburi	Huay Muang, E-wawng
Roiet	Hawm Nahng Nuan, Pamah
Sakon Nakhon	Khitom Hahng Nahk, Plawng Aew, E-khao Kam
Satun	Bow Toon, Al-humdulila, Rachinee
Sing Buri	Khao Tah Haeng l7 (improved local var.), Leuang Pratew, Pin Gaew
Songkhla	Jangwat, chaw Lung, Khai Mod Rin
Sra Gaew	Leuang Awn, Khao Tah Haeng, Jek Chuey
Suphan Buri	Khao Phetchabum
Surat Thani	Leb Nok, Gantang, Chaw Nimit
Surin	Niang Guang, Nahng Loi Yai, Mali Daeng (mutated local var.)
Tak	Puang Tawng, Beu Kae, Bue Taw La
Trad	Khao Lon Yung
Trang	Hoi Sang, Al-humdulila, Jampah
Uthai Thani	Luang Pratah, Jek Kradod, Leuang Rai
Uttaradit	Khao' Bid, Khao' Hawm, Khao' Plah Sew Kam

Annex 14 Name of entities coordinating and/or facilitating PGRFA activities

Name of entity	Year of establishment
The National Conservation and Biodiversity Committee	2000
Mahidol University	1969
Kasetsart University	1943
Chulalongkorn University	1916
Health Systems Research Insitute of Thailand Research Fund	1992
Agriculture Research Development Agency	2003
Community Organization Development Institute	2000
National Science Museum	1995
Nation Science and Technology Development Agency	1991
The Institute for the Promotion of Teaching of Science and Technology	1972
Chiang Mai University	1964
Khon Kaen University	1966
Burapha University	1955
Prince of Songkla University	1967
Maejo University	1939
Ubon Rajathanee University	1987
Rajmangala University of Technology Thanyaburi	1975
Silpakorn University	1943
Ramkhamhaeng University	1971
Sukhothai Thammathirat Open University	1978
The Northeastern Thailand Biodiversity Center	1998