Plant Genetic Resources Conservation and Development in Thailand : Food Crops

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1. Introduction

Thailand lies between 5° and 21° N latitude and between 7° and 106°E longitude. It is characterized by warm sub-humid tropics. Four seasons are recognized: southwest monsoon from May through September, a transition period from the southwest to the northeast monsoon during October, the northeast monsoon from November through February, and a premonsoon hot season during March and April.

Geographically and administratively, Thailand is divided into four regions: the Central, the North, the Northeast and the South.

Central region. The Central region, drained by the Chao Phaya river system, is an intensively cultivated alluvial rice land which accounts for about 21 percent of the total cultivated area of the country. Rice is produced mainly for export, and farmers adopt green revolution technology for continuous rice cultivation throughout the year.

Northern region. The north constitutes the upper North and the lower North accounted for about 22 percent of total cultivated area. The upper north is characterized by high mountain ranges, occupying about 78 percent of landform, while the lowlands make up only 10 percent. With diverse topographic features, rice diversity is also greatest. Farmers make use of diverse rice germplasm to produce glutinous rice for subsistence in the wet season. The lower North, on the other hand, has contiguous lowland ecosystem that extends to the central region. It is also the rice-exporting region, producing non-glutinous rice for commercial market.

Northeast region. The Northeast has the largest cultivated area, occupying about 44 percent of the total farming area. Agricultural productivity is lowest due to environmental stress such as soil erosion, drought, salinity and sandy soils. Farmers produce glutinous rice for consumption and non-glutinous rice for market. The lower Northeast is well known for producing high quality rice KDML 105 variety for export.

Southern region. The Southern peninsular constitutes about 13 percent of the total cultivated area of the country. It is characterized by mountain ranges and high rainfall. The major land-use is of plantation crops such as rubber, oil palm, and perennial fruit trees. With only 6 percent of total rice land, the region always experiences rice shortage for local consumption.

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Cereals	Rice, maize, sorghum, wheat, barley
Pulses	Mungbean, soybean, peanut
Roots and tubers	Cassava, potato, sweet potato, taro
Oil crops	Oil palm, coconut, soybean, peanut, sesame, sunflower
Sugar crops	Sugar cane
Beverages,	Coffee, tea
Fruits	Citrus, mango, durian, rambutan, papaya
Vegetable crops	Onion, garlic, shallot, cabbage, chilli

2. Genetic resources of food crops in Thailand

Thailand is a food exporting country. There are at least 8 crop categories that being used as raw materials for the food industry in the country (Table 1).

With the exception of rice majority of food crops grown commercially are not indigenous species, but are introduced and with subsequent selection by farmers and improvement by the Department of Agriculture, have become economic crops.

Cereals:

Five cereal crops, rice, maize, sorghum, wheat and barley are grown commercially. Rice is the staple food crop with planted area about 9.7 mha. During the last four decades, the Department of Agriculture (DOA) has released over 50 varieties either with general or specific adaptability to four growing regions in the country. About one-third of the recommended varieties are derived from local selections.

Maize (*Zea mays* Linn) is produced mainly for livestock feed, about 80 percent of the production is used domestically and only 20 percent is exported. The crop is introduced, and the broad-base populations derived from the CIMMYT and other collaborative research programs have provided valuable materials for national breeding program. In addition, the crop has provided good incentive for the multinational seed companies to invest in producing hybrids. The last five years have witnessed the increasing use of maize hybrids by farmers, with estimate of about 40 percent of cultivation area being planted to hybrids.

Sorghum (*Sorghum bicolar* (L.) Moench) is planted as a second crop after maize or in the drier parts of the maize zone in the lower North and Central region of Thailand. The crop is not indigenous, and the production is mainly used for livestock feed.

Wheat *(Triticum aestivum Linn.)* and barely (*Hordeum vulgare* Linn.) are considered to be new crops specifically selected for farming systems in the North and northern part of the Northeast. The germplasms of spring wheat and malting barley are mainly introduced from the CIMMYT. The research and development of wheat and barley is a joint effort among the Chiang Mai, Kasetsart Universities, DOA and the private malting companies in the North.

Pulses:

The main pulse grown commercially are mungbean soybean and peanut. These crops are not indigenous species, but have been introduced as cash crops for several decades. The Asian Vegetable Research and Development Centre (AVRDC) has contributed germplasms for mungbean and soybean development and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for peanut development significantly.

The mungbeans (*Vigna radiata* (L.) Wilczek), both green gram and black gram (*V. mungo* (L.) Hepper) are adapted well to irrigated and rainfed environments and being short maturing crops, they fit well in diversed cropping systems. The products are mainly used for the domestic consumption.

Grain soybean (*Glycine max* (L.) Merill) under tropical environment matures in 95-110 days, thus it has been incorporated in rice-based cropping system in irrigate lowland, or sole cropping system in rainfed upland. About 15 percent of the production is processed as food, over 70 percent is processed as edible oil, and the meal is used as livestock food. The recommended varieties are relatively environmental specific. For instance, SJ 4, SJ 5 and Chiang Mai 60 are adapted favorably under irrigated lowland in the Upper North while Sukothai 1 is more productively in wet season in the uplands of the lower North. The NS-1, the large grain type, is adaptive to the Upper Central-Lower North interface. The new recommended variety KKU 35 is promising in the Northeast condition.

The high yielding recommended varieties, SJ 4, SJ 5, CM 60 and KKU 35 are derived from three parental lines namely, SJ 2, Tainung 4 and Williams, thus creating relatively narrow genetic base which could be vulnerable to diseases.

Peanut (*Arachis hypogaea* Linn.) is not indigenous crop. The traditional varieties, Lampang and Sukothai 38, were selected from locally adapted populations and released as varieties in 1962. They are small-seed types. The selections from the introduced germplasm such as Tainan (released in 1976), is widely adapted, and KK 60-1, KK 60-2 (released in 1987) and KK60-3 (released 1988) are large-seed type. Which are mainly used as confectionery. The most recent recommended variety, KK 60-4, is derived from the cross between (Taiwan 2×UF 71513-1). It is small seed type but high yielding.

However, there are certain locations, which still continue to grow locally adapted farmer own variety, for instance, in the Phrao district of Chiand Mai province. The local variety possesses 3-4 seeds/pod, and the crop is harvested at physiological maturity. The pods are steamed and sold as steamed peanut.

Roots and Tubers:

Cassava (*Monihot esculenta* Crantz.) is commonly grown in poorer growing conditions in the Northeast and the Central regions, which accounts for about 85 percent of the total planted area. About 75 percent of root materials are processed into pellets and chips for export, and the remaining 25 percent are processed as native starch and modified starch.

Cassava is an introduced crop. At present 8 varieties have been released, only one variety, Rayong 2 is of sweet type and used for human consumption. The other 7 varieties are for industrial use.

Sweet potato (*Ipomoea batatas* (L.) Lam) is grown as garden crop in a mixed farming system or as contract crop with monocropping on a larger field. The improvement is still at a low level of development because of the low priority. The current available varieties are from locally adapted selections. Where farmers keep their own planting materials.

Potato (*Solanum tuberosum* Linn.) is an introduced crop. The tuber seed of tradition variety, Binje, is imported from the Netherlands, and has been used for cooking and processing locally. With the development of fast food industry, new processing potato varieties have been introduced from the Netherlands, the U.S. and Australia for field trial and quality evaluation. For instance, the Russet Burbank variety has been evaluated for yield and french fry quality. The potato is mainly cultivated in Chiang Mai province.

Taro (*Colocasia esculenta* (L.) Schott.) is commonly grown by the Karen hilltribe in the North during the rainy season. The crop is grown as cash crop on the most fertile plot. The diversity of germplasm is still unexplored.

The Assam-Upper Myanma is considered to be center of diversity of taro, and northern Thailand could be a diffused center.

Oil crops:

The oil palm *(Elaeis guineensis* Jacq.) is the most rapidly expanding plantation crop in the tropics . The crop was first established as major industrial crop in Malaysia and Indonesia, and later extended to the Southern region of Thailand, covering the area of about 0.15 mha. It has narrow genetic base, for the seedling derived from the four palms planted in the botanical garden at Bogor, Indonesia, which originated from an unknown source in Africa (Arasu and Rajanaidu, 1975). Majority of palm seedling were imported from Malaysia.

The coconut (*Cocos nucifera* Linn.) with planted area of about 0.38 mha, is the most important oil crop for small farmers in the southern peninsular, as contrast to the oil palm where the crop is established as plantation crop by resources-rich farmers.

The coconut was reported as native plant originated from the Pacific Islands. The DOA had initiated the coconut breeding program in 1974 and has released two varieties: Sawee Hybrid-1 and Chumporn Hybrid 60, derived from the cross between local, tall and Malaysia dwarf parental lines.

Sugar crops:

Sugarcane (*Saccharum officinarum* Linn.) is the main sugar crop in Thailand with planting area of about 0.94 mha. The introduced varieties by the private sugar refinery companies are sometimes recommended directly to the contract growers. All the parental lines used for breeding program are also introduced. At present, there are 29 varieties that are recommended to fit specific growing environments.

However there are thin cane types that grow for local market for chewing, and syrup is extracted for making sugarcane drink.

Fruit crops:

Fruit crops are now regarded to be the most promising solution to establish sustainable land-used. They are integrated into various forms of land-use, such as

home garden, agroforestry systems, commercial fruit orchards, etc. Over one million ha. of land has been planted with 35 economic fruit tree species in 1995. But only about 10 species are cultivated on larger scale and managed professionally as commercial farms (Table2).

Fruit growers and private nurseries have contributed significantly to the development and distribution of new fruit species. But the germplasm collection and evaluation is still carried out by the Horticultural Research Institute of DOA.

. Table 2 Ten major fruit crops in Thailand (1995)

Fruit crop	Planted area (ha)
Pineapple	320,000
Mango	224,000
Durian	88,000
Rambutan	80,000
Longan	28,800
Mangosteen	19,200
Pomelo	16,000
Lichi	10,400
Tangerine	9,600
Grape	4,800

Source: Gypmantasiri, *et al* (1998).

3. Genetic erosion of crop plants

Nearly all the economic food crops in the country are introduced. The development process follows mainstream plant improvement procedures: germplasm collection, evaluation, parental selection, hybridization and recombination, management of segregating population, selection decision and multi-year, multi location trails of elite lines and finally the multiplication of promising or recommended varieties or cultivars. The process is still under the decision and management of the breeders of governmental research institute, either the DOA or universities. In practice there is no farmer participation in the process. However there is certain exception in the case of fruit crops.

As shown in Table3, the recommended varieties for important varieties for economic food crops in Thailand are not many. Indeed, our agricultural development is based on limited numbers of crop plants and with narrow genetic base

Table 3 Planted area, farm value of major food crops and extent to which small number of varieties dominate planted area (1994)

Crop	Planted area	Value	Total	Major	% planted area

	(mha.)	millionsdollars	varieties	varieties	
Rice	9.7	3127	52	6	54
Maize	1.4	466	11	4	60
Mungbean	0.4	99	4	3	100
Soybean	0.4	15	9	5	100
Peanut	0.1	54	5	3	100
Cassava	1.3	835	8	4	100
Oil palm	0.1	132	Na	Na	Na
Coconut	0.4	159	2	2	Na
Sugarcane	0.9	880	29	Na	Na

Genetic erosion in rice

Thailand is considered one of centers of diversity of *indica* rice (Chang, 1976). There is a great concern when the policy of rice export promotion being implemented. The DOA, through the Rice Research Institute, has given high priority to develop high quality and high yielding irrigated lowland rice. The breeding strategy is to incorporate high yielding parental lines from IRRI to the local adapted lines in multiple crosses. In recent year, in addition to develop non-photosensitive aromatic rice, disease and insect resistance have been incorporated through back crosses. The resulting improved varieties are released to commercial rice farmers through the DOAE by various forms of promotion/extension programs (Table 4). For instance, selling rice seed at low price, seed exchange program by encouraging farmers to exchange seed of traditional varieties with new improved varieties at 1:1 ratio, etc.

We have witnessed the rapid increase average of modern high yielding rice varieties as shown in Table 5 as the result of production and export promotion of Thai rice. This is particularly significant in the main rice cultivation area in the Central plain. The contribution of non-photosensitive varieties (the RD rice series) allow the continuous rice cultivation throughout the year.

In Northern Thailand, particular the Upper North where land form is in characterized by highlands, uplands and lowlands, and average farm size is about one ha, farmers grow glutinous rice for subsistence in the wet season. The 1991 survey (Table 4) showed that in Chiang Mai the local varieties, RD 6 (photosensitive), and other photosensitive varieties had made up about 56.4 percent of rice planted area. There are mainly photosensitive and only grown in the wet season. The high quality export rice, KDML 105, a photosensitive variety, is grown in the wet season as cash crop. It covers almost 20 percent of the rice area., which is considered to be high for single variety. The Basmati rice, introduced and selected by the large rice milling company, is grown on contract for export market.

The local varieties, planted in Chiang Mai, which accounts for 22 percent of the rice area, are all photosensitive and glutinous rice which are not entered the rice market. They can still be found in various river basins and normally would possess early maturity character. Farmers use such varieties to fit various cropping systems that require cool season for second crops after rice, such as garlic, chilli, etc.

The RD 6 is glutinous rice derived from non-glutinous KDML 105 by irradiation. It is becoming popular and accepted by farmers because of its good

cooking quality. It is now replacing the traditional glutinous rice variety, Niew San Patong.

Table 4 also indicates that Chiang Mai lowland valley, about 50 percent of the rice area is planted to RD6 and KDML105 which are genetically similar. The variety is susceptible to leaf blast caused by *Pyricularia* species.

However it is found that almost all the paddy rice varieties grown on the highland are local or landraces. The modern high yielding varieties as developed for irrigated lowland could not thrive well under cooler environment and with low light intensity. Work at the Multiple Cropping Centre has shown that the 49 rice samples collected from the Karen farmers' fields were genetically different and could be clustered into 34 groups based on zymogram patterns. But the Karen farmers name their rice varieties with only a few names, based on plant and grain morphology. This would indicate that farmers have planted their rice with mixed lines of similar phenotypes. The use of multi-line has proved to provide stable yield under varying environments (Borlaug, 1959; Frey *et al*., 1975; Groenewegen, 1977).

Table 4 Reaction to disease and insect pest of recommended lowland rice varieties.

Variety	Parents	year of	Reaction to disease and insect

		release	BL	BB	RTV	GSV	BPH	GLH
RD1	LT/IR8	1969	S	S	S	S	S	R
RD2	GP152/TN1	1969	S	S	MS	S	S	R
RD3	LT/IR8	1969	S	S	S	S	S	R
RD4	LT/IR8//W1252///RD2	1973	S	S	S	S	R	R
RD5	PN16/Sigadis	1973	MR	MR	S	S	S	S
RD7	C4-63/GR88//Sigadis	1975	MR	R	S	MS	S	R
RD9	LY34/TN1//W1256///RD2	1975	S	VS	MS	MS	R	R
RD11	IR661/KDML105	1977	S	S	S	S	S	S
RD21	KDML105/NMS-4//IR26	1981	S	MR	S	MR	R	MR
RD23	RD7/IR32//RD1	1981	S	R	S	MR	R	MR
RD25	KDML105/IR2061//KDML105/IR26	1981	S	MR	S	MR	R	MR
Suphanburi 60	LT/C4-63//IR48	1987	R	MR	S	MR	MR	R
Phitsanulok90	RD1/BR51-91-6//SPR6726-134-1-24/IR34	1987	R	R	R	MR	MR	R
Suphanburi90	RD21/IR4422//RD11///RD23	1991	R	MR	MR	R	R	MS
Chai nat1	IR13146-158-1/IR15314-43-2-3-3//BKN6995-16-1-1-2	1993	MR	MS	S	R	R	MR
Phrae1	IR2061-214-3-14/RD4	1994	MR	MR	-	-	-	-
Suphanburi1	IR25393-57-2-3/RD23//IR27316-96-3-2-2///SPR77205-3-2-1-1/SPR79134-51-2-2	1994	R	R	MR	MR	R	MS
Suphanbiri2	RD23/IR60	1994	MR	R	MR	MR	R	MS

Note: MR = Moderately resistant, MS = Moderately susceptible
R = Resistant S = susceptible

Table 5 Percentage of planted area to different rice varieties (1991)

Variety	Whole country	North	Chiang Mai
1 Local	32.5	48.0	22.2
2 RD 6	25.2	15.5	29.7
3 RD16	3.7	2.4	-
4 KDML 105	19.1	5.0	19.5
5 Photosensitive	8.0	9.0	4.5
6 RD 21 and RD 23	5.6	10.0	-
7 Suphanburi 60	0.6	1.8	-
8 Non-photosensitive	5.2	8.0	20.8
9 Basmati	0.1	0.3	3.3
Total rice planted area 1991 (mha.)	8.83	1.95	0.07

4. Government programs and policies that affect PGR conservation

The most comprehensive plant genetic resources conservation and development activity is perhaps occurred in rice crop. The PGR conservation program dated back to early 1950s when Dr. H.H. Love of Cornell university initiated the nationwide rice germplasm collection in then the Rice Department. Some of local varieties, particularly adapted to specific growing environments, such as upland rice, deep water rice, are still in use today.

Since Thailand is a rich source of rice diversity, and the rice genetic resources provide the basis for crop improvement that would respond to government rice export policy, the DOA has therefore established a modern rice gene bank with the support of the Japanese Government. The current rice coessions stored in this gene bank total……

As far as field crops are concerned the PGR conservention activities are less comprehensive. The collection, evaluation and utiliztion are carried out at the Field Crops Research Centers (8 centers focusing on different commodities). The set up at the regional centers can only provide short term storage facilities, therefore only the "working collection" (less than three years storage) are possible.

The recent controversial issues on intellectual property right, local knowledge and farmer right and biodiversity, have aroused public interest and awareness on the social economic and ecological contributions of plant genetic resources. Thus the PGR conservation and development has been included in the research agenda within the biodiversity framework. The PGR conservation studies have now extended to cover under and unexploited species. The final aim is to develop the species to become marketable commodities for food, medicine, industrial values and habitat beautification etc.

The government policy to promote sustainable land-use with the emphasis on perenial fruit tree species has caused the great interest in conserving and utilizing both major and minor fruit tree species. Local varieties with good quality and the derived fruit products have been promoted by the Provincial authority in order to generate farmer incomes. The practice is also in line with the policy of Ministry of Interior to promote the outstanding agricultural products for every province in the country. With all these efforts, we have seen increasing the contribution of local farmers and private nurseries in developing and distributing good tree seedlings.

The government policy to promote export oriented agriculture in the better endowned farming environment results in monoculture of food crops. In the case of the commercial rice production is based on a few varieties (Table 3). The highly praised jasmin rice is cultivated to single variety, KDML 105. It covered about 20 percent of the rice planting area in 1991 and increasing. Other economic food crops, as discussed earlier, are not indigenous. Through introduction and hybridization, they are developed and have become economic commodities. But the numbers of recommended varieties are not many and the genetic base is narrow. So it can be seen that our economic food crops are highly vulnerable, and this vulnerability stems from genetic uniformity.

Table 3 shows that only a few varieties have dominated the planted area. This poses a dilemma : how can one has the uniformity one demands without the harzards of crop failure due to pest epidemics?

One apporch that we have seen in the case of rice is to develop variety by multiple crosses, where parental lines with different reaction to diseases and insects are recombined to form a broad base for pest tolerance or resistance, such as the new variety Chainat No. 1

5. Conservation programs and methods

There are several agencies related to agricultural that have developed the PGR conservation programs on food crops. The main institutions are as follows :

- The department of Agriculture (DOA)
- The Agricultural Universities
- The Princess Maha Chakri Sirindhorn Initiative Project on Plant Genetic Resources Conservation
- The non-governmental organization

The DOA: The crop research institutes within the DOA are responsible for developing crop varieties and agronomic packages for yield improvement. The research institutes are located in different regions representing the potential production zone for major crop plants. The PGR conservation and utilization activities are carried out within the centers which have the seed storage facilities for the " working collections" purposes. Each center has a number of satellite experimental stations located in the nearby provinces. The main function of station is to conduct field test on crop varieties and technology packages.

Rice Research Institute: There are seven rice research centers and 16 experimental stations throughout the rice growing areas as shown in Table…. Each center has its own mandate to develop rice production technology for different rice ecosystem.

Table 6 Rice research centers and their research focus

Center	Region	Major emphasis
1. Pathum Thani	Center	Irrigated lowland rice, Acid sulphate soil
2. Prachinburi	East	Deep water rice
3. Phatthalung	South	Peat soil, lowland and upland rice
4. Phitsanulok	Lower North	Irrigated lowland rice
5. Phrae	Upper North	High altitude paddy rice, Dryland rice
6. Ubon Ratchathani	Lower North east	Rainfed lowland rice, Saline soil
7. Sakhon Nakhon	Upper North east	Rainfed lowland rice, Saline soil

The experimental stations based at Samoeng. Chiang Mai province and Pangmapha, Mae Hong Son province are the main stations conducting research on winter cereals : wheat and barley.

Field Crops Research Institute: Essentially all field crops are under the responsibility of FCRI. There are 8 research centers and 12 experimental stations. Each centre will emphasize on the crop species that are adapted well in the region. The eight research centers are listed in Table 7

Table7 Field Crop Research Centers and their respective Major Crop research

Center	Region	Mandated crops
1. Khon Kaen	Upper Northeast	Peanut, roselle, kenaf, jute, safflower, ramie.

2. Chai Nat	Central	Mung bean, blackgram
3. Nakorn Sawan	Lower North	Maize, cotton, kapok
4. Rayong	East	Cassava
5. Suphan Buri	West	Sugarcane, sorghum
6. Ubon Ratchathani	Lower North east	Sesame, castor, cowpea
7. Chiang Mai	Upper North	Soybean, sunflower, vegetable corn, paper mulberry
8. Songkhla	South	Bambara ground nut

Horticultural Crops Research Institute: Within the Horticultural Crops Research Institute, there are 8 research centers and 15 experimental stations. The centers and their respective mandated horticultural tree species are listed in Table 8

Table 8 Horticultural research centers and their mandated crops.

Center	Region	Mandated Crops
1. Chan thaburi	East	Durion, Rambutan, Mangosteen, Sala etc.
2. Chumphon	South	Coconut, Pineapple, Cacao etc.
3. Phichit	Lower North	Pomelo, Banana, etc.
4. Si Sa Ket	Lower Northeast	Cashew nut, Papaya, etc.
5. Chiang Rai	UpperNorth	Lichi, Longan, Citrus.
6. Surat Thani	South	Oil palm, Langsat
7. Chiang Mai	Upper North	Sub-temperate fruits: peach, palm, persimmon etc.
8. Trang	South	*Parkia speciosa*

The Princess Maha Chakri Sirindhorn Initiative Project on Plant Genetic Resources Conservation: The Princess Maha Chakri Sirindhorn Initiative Project is a non-governmental organization. Under the plant genetic resources conservation activities, the Project helps coordinate and provides support for the PGR conservation and utilization works to various research instituties, universities and Rajamangala Institute of Technology which has agricultural campuses in different regions of the country. The project is concerned with under and unexploited perennial species which are not the mandated species of the Royal Forest Department or the DOA. The main activities include collection, characterization, and evaluation either *in situ* or *ex situ* The species analysis also extends to determine various uses as food, medicine, industrial and non-harvest related recreational values. The conservation is either carried out *in situ* or *ex situ*. There is also an effort to promote community participation in PGR conservation.

The Non-governmental organizations (NGOs): In 1990, there were about 375 NGOs that had carried out their own development programs or projects for the benefits of the less privileged communities. Only a few are engaged in PGR-related activities. Two examples are briefly described below:

1. Hag Muang Nan Network. This is a development network in the Nan Province in the Upper North, coordinating all NGOs programs or project within the province. The Network has successfully established a good working relation with the provincial governmental authorities. The PGR conservation is one activity of the Network.

The PGR conservation includes upland rice, local vegetable crops, and medicinal plants. The initial collection is carried out by the network staff. The evaluation of the accessions are carried in cooperation with farmers. Exchange and request of seeds among farmers for planting is facilitated by the network staff.

2. Technology for Rural and Ecological Enrichment (TREE).

The organization is based at Suphanburi province. Its advocacy is to promote alternative agriculture non-Green Revolution technology approach. It places high values on farmer wisdom and local knowledge.

Suphanburi is the main commercial rice production area with good irrigation facility and transportation network. Farmers adopt high input production system for rice cultivation. The TREE has collected and evaluated local lowland rice and designed the breeding program to develop new varieties for low input production system.

So far, the PGR conservation and development for food crops is the mandate of the DOA. The rice and fruit crops accessions are mainly collected from all over the country. The germplasms of economic food crops as disscussed in the text are mainly introduced. The accessions are evaluated in their respective crop research centers or "satellite" stations. The conservation is carried out *ex situ.*

The PGR conservation and development programs among the agricultural universities are short-lived. The program requires commitment and long term support; and the output of the PGR conservation should link or be supporting to other research activities, which is lacking within the universities.

The PGR conservation by itself, should not survive or has any significant impact without other related research activities, such as breeding program, food processing, utilization, etc.

However, the Kasetsart University with long commitment on maize and sorgrum improvement, has been taking the responsibility of managing the National Maize and Sorghum Research Center. Thus the PGR conservation of the Kasetsart University is perhaps the most active.

The Princess Maha Chakri Siridhorn Initiative Project and a number of NGOs have encouraged the participation of local communities in PGR conservation. This would require a closed working relation with the local, creating an appreciation among the communities about the values of PGR and its contribution to their livelihood system.

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