RICE COLLECTION AND CONSERVATION ACTIVITIES IN THAILAND*

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ABSTRACT

Local rice collection for the purpose of varietal improvement was pursued intensively during the period 1950-1967 and resulted in accumulation of 6,739 samples. If classified by endosperm type, 2,122 (31.5%) were glutinous and 4,619 or (68.5%) were non-glutinous. Based on the area where collected, 229 (3.4%), 5,888 (87.4%), and 622 (9.2%) of the samples were upland, lowland, and floating types, respectively. These were originally evaluated for yield and grain quality by personnel at the rice experiment stations. Only those samples that showed promise were saved for further yield tests over years. These efforts resulted in several government recommended varieties released to farmers some of which have persisted and are still grown extensively.

Local collections, which did not show sufficient promise to be released as varieties but appeared valuable for future breeding programs, together with prize-winning varieties from local rice competition exhibits and foreign introductions were maintained as germplasm by the rice experiment stations. It was necessary to store the seed samples at room temperature and replant every year or two to maintain viability. Since 1972, with the availability of an air conditioned room at the Bangkhen Rice Station, all collections have been given genetic stock numbers, maintained and characterized at Bangkhen, Bangkok. At Present, there are 3,050 accessions of which 2,434 have been catalogued. About 63% of the collection involves indigenous varieties. It is estimated that only 2,000 of these may be viable due to poor germination and unsuitable storage facilities.

Since 1966 the collection of indigenous varieties has been utilized for studies such as protein content, chemical and physical properties of the grain, resistance to some diseases and insects, and tolerance to problem soils.

Factors concerned in the genetic deterioration of rice have been discussed. It is suggested that collection should be intensified especially in remote areas and those places where the HYV's are spreading rapidly. However, the problems of financial support, good storage facilities, and well-trained personnel need to be solved before such work begins.

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The Kingdom of Thailand occupies an area of about 542,373 square kilometers in the Indo-Chinese peninsula of Southeast Asia. It extends from 5°N to 21°N latitude and from 97°E to 106°E longitude.

Thailand is divided into 71 provinces which are grouped into four regions based chiefly on topographical similarity. These four regions are the Northern, Northeastern, Central Plain, and the South. They consist of 16, 15, 26 and 14 provinces, respectively (Figure 1 and Table 1).

Rice is the main staple food crop of the Thai people and a major foreign exchange earner. As one of the world major rice suppliers the country exports over one million tons of milled rice annually. The total area planted to paddy stands at about 7.6 million hectares, accounting for about 75% of the total area under agricultural cultivation. About 11% of the rice fields are planted to floating rice, 1% to upland types, and the remainder is devoted to lowland rice forms.

Varietal diversity of the country

Thailand has been considered as one of the richest genetic resources of rice in the world. Perez and Chang (1974) estimated that approximately 3,500 local varieties of rice exists in Thailand. The genetic diversification and ecological specialization is due to several factors, e.g.,preference in local consumption and markets, adaptation to edaphic and topographic conditions of paddy fields and water regimes.

Rice production in the North and Northeast is usually only sufficient for local consumption. People in these two regions consume mostly glutinous rice. In the South and Central Plain the non-glutinous varieties are preferred.

There are a multitude of rice varieties adapted to different topographic and eco-edaphic environments. The Northern and Southern regions are mountainous areas consisting mostly of loamy soils. Farmers grow lowland types by using transplanted culture in paddy fields in the comparatively small valleys lying between mountain ranges and also grow upland rice at upper levels. The Northeastern region is an undulating plateau in its northern half and relatively flat in the southern half. Paddy soils in this area are drought prone, infertile, and mostly sandy. Most of the varieties are transplanted lowland types but some upland froms are grown although their total area is small. The Central Plain is a vast flat alluvial region surrounded by mountains to the west, east and north. It consists of heavy clay soils. Lowland varieties are grown using both transplanting and broadcasting methods. In areas where water is deep, floating rice varieties are grown. Paddy fields in this region produce the major portion of rice for export.

The growing seasons of rice are strongly influenced by two monsoons. The southwest monsoon of summer commences around May and continues until the middle of September. During this period it brings considerable rain to the North, Northeast, Central Plain, and the west side of the Southern peninsula. The northeast monsoon winds begin to blow in October and continue until April. During this period there is very little rain except on the east coast of the peninsular South which receives moisture brought from the Gulf of Thailand. This is the so-called dry season for other regions.

Following along these annual seasonal changes closely are two rice seasons for Thai farmers. They produce the main season rice in the wet season and the off season rice in the

dry. Most rice varieties grown in the wet season are tall and sensitive to photoperiod. The North, Northeast, and west side of the South have rather short duration rainfall; farmers tend to grow mostly early maturing varieties. Planting begins as soon as the southwest monsoon starts in May and harvest occurs from October to December. Rice fields in the Central Plain, besides obtaining moisture from the southwest monsoon, receive additional amounts from flood waters from four rivers which flow from the North and provide a longer growing season. Farmers here grow medium and late maturity varieties especially in the low areas. They sow the seed early in April in order to avoid flooding at the seedling stage. Harvest time starts in late October and continues to February. Farmers on the east coast of the Southern peninsula, which is under the influence of the northeast monsoon, have their wet season planting from September to March.

The cultivation of off season rice is performed in irrigated areas which measured approximately 214,000 hectares in 1976 and continue to increase annually. The cultivation period for this crop runs from December to July. Only modern non-sensitive high yielding varieties (HYV's) which have been released since 1969 are grown. This crop attained economic importance only recently eventhough some indigenous tall non-sensitive forms were earlier used on a small scale.

All the indigenous rice varieties in Thailand are Asian cultigens of the Indica type. Wild or weed races can be found throughout the country in swamps, canals, and areas close to paddy fields. Sometimes these races are found sporadically in rice fields also. Thus, natural hybridization between wild or weed races and cultivated varieties occurs.

Rice collection and maintenance

Although Rangsit Rice Experiment Station was established in 1916, all breeding work before 1950 was confined to improving the quality of grain. Large-scale scientific breeding work began after the arrival of Dr. H.H.Love in 1950 as part of teahnical assistance from the Office of Foreign Agricultural Relations of the United States Government (Love, 1955). He launched a comprehensive project consisting of three phases: variety evaluation, selection within the local material, and hybridization.

As part of the project, during the years 1950-1967, requests were made to agricultural agents and others stationed in different parts of the country to collect seed of rice varieties grown in their localities. This resulted in 6,739 samples, from 67 provinces, which could be classified into two groups according to their endosperm types. The glutinous types consisted of 2,122 (31.5%) samples and 4,619 (68.5%) were non-glutinous. If based on their ability to grow under different water regimes, 229 (3.4%), 5,888 (87.4%), and 622 (9.2%), were upland, lowland, and floating types, respectively (Tables 1 and 2.) It should be pointed out that many original seed samples were the same varieties due to their popularity among farmers and several collections were made in the same areas. It is not possible to present an accurate count of the total number of varieties collected in the early period because many samples bearing the same name had varied flowering dates up to one month difference and also had different endosperm types.

Figures 2-5 show the areas where local rice varieties were collected during the years 1950-1967. The bulk of the collection consisted of lowland varieties (Figure 4) and the most extensive collection was done in the Central Plain especially in areas close to Bangkok. It should be pointed out that the scattered dots shown by province in Figures 2-5 do not

indicate the exact locations where collections were performed but merely represent the numbers of seed samples obtained. Seed samples were not collected from all districts of those provinces. Many remote areas still remain untouched.

The main objective of collection at that time was to obtain as many indigenous types as possible for observation at several experimental stations. Varieties that showed promise were then put in replicated yield trials over years and those having poor performance were discarded. These careful tests resulted in many government recommended varieties released to farmers. Some gained popularity rapidly and have been grown extensively since their release. For example, the glutinous varieties Niaw Sanpatong and Muey Nawng 62M are popular among farmers in the North and Northeast, while the non-glutinous varieties Khao Dawk Mali 105 and Nahng Mon S-4 are grown extensively in the Central Plain. Nahng Praya 132 is used widely in the South. However, it sould be emphasized that despite the popularity of certain government recommended varieties, many farmers continue to grow their own forms possibly because of better specific adaptation, taste or failure of the extension service to promote the government varieties.

In addition to the above local collection the germ plasm stocks contain several foreign introductions and prize-winning varieties from local rice competition exhibits. The exhibits are held annually by the Ministry of Agriculture to encourage farmers to take an interest in high quality rice. These were also grown in observation plots, cataloged and maintained in the genetic stocks.

Samples which had undergone several years testing but were not quite good enough to be released as varieties but might be valuable for future breeding programs were originally maintained as genetic stocks at the different experiment stations. Seed samples were kept in glass jars at room temperature which were rejuvenated every year or every 2-3 years in some stations but were not at others. Thus, many varieties were lost due to poor germination and damage. In 1966, collections from the stations were sent to the Bangkhen Rice Experiment Station in Bangkok for study of some important characters. Duplicates of the same varieties were discarded. Since 1972 with the availability of an air conditioned room all collections were given genetic stock numbers and characterized. Further collections of indigenous varieties have been made occasionally since then but this has not resulted in a large increase in the number of samples. Some foreign introductions and breeding lines have been added as deemed advisable. At present there are 3,050 accessions in the germ plasm collection. Table 3 shows the various types presently available.

After the release of the HYV's in 1969 by the Department of Rice (later Rice Division) many local varieties disappeared from the paddy fields, especially in the irrigated areas of the Central Plain. Some farmers have abandoned their old varieties and use the more productive HYV's in both wet and off seasons. In certain areas, farmers still grow their indigenous photo-sensitive varieties in the wet season, and use only HYV's in off season. As the irrigation system is expanded and improved it is expected that more farmers will depend on HYV's for their rice production in both seasons.

Seed storage and maintenance

At present, all genetic stocks (3,050 accessions) are kept at Bangkhen Rice Experiment station, Bangkok, in an air conditioned room. About 63% of them are indigenous rice varieties. The others are foreign introductions and breeding lines (Table 3). Because of poor germination of many accessions, which have not been regenerated for several years,

unsuitable containers, and relatively high temperature and humidity in the storage room, it is estimated that only 2,000 accessions are viable.

Seed samples, after drying and cleaning, are stored in two types of containers. Small samples (10-15 gm) are placed in small tin cans. Large samples (500 gm) are stored in glass jars. No chemicals are applied to the seed. All seed containers are placed in a 5 x 7 x 3.5 m^3 air conditioned room with temperature around 23°C and 80% relative humidity.

Since 1973, characterization, evaluation, and rejuvenation of the accessions have been performed annually by personnel from the main office of Rice Division. Each year seed samples of 500 accessions are grown in the wet season for characterization and evaluation. An additional group of 300 samples which have only small amounts of seed or have been kept for many years, are regenerated. Twenty different characters are usually recorded for each accession. In the following year an additional two groups of 500 and 300 accessions are grown for characterization and rejuvenation. There are 2,434 accessions presently catalogued. It is expected that every accession will be rejuvenated every five years by the above procedure.

Research of an academic nature on the collected samples

Since 1966 a total of 1,787 samples of indigenous rice varieties were analyzed for their protein content. The main objectives of this protein analysis were to identify genotypes that might be of value for immediate use to solve the problem of protein deficiency in the Thai people's diet and identify useful breeding genotypes (Duangratana, 1972). Through subsequent screening and replicated multi-location yield trials, three indigenous varieties from the local collection and two government recommended varieties have shown good performance for both high yield and protein content (Khambanonda, *et. al.*,1974).

Furthermore, Attaviriyasook (1974), seed analyst of the Rice Division, analyzed some chemical and physical properties of 344 samples from thd genetic stocks. One of the objectives of her study was to characterize Thai rice and assess the variability among and within regions. Her findings showed that upland forms of the North tended to have low amylose content. The floating varieties of the Central Plain contained a predominance of types with intermediate gelatinization and Southern types tended to have bold grain.

Hamamura *et. al.* (1977) reported studies which were conducted from 1972 to 1974 with three groups of local rice varieties. In 1972, a group of 281 varieties were studied and 23 characters observed. In 1973, a group of 922 varieties were chosen and 16 characters recorded. Data were analyzed by Principal Component Analysis. Maturity and endosperm types were considered to be two major characters to classify Thai rice varieties. Seven groups of rice were recognized through scatter diagrams of the varieties. Several varieties were noted to be resistant against Bacterial Leaf Blight disease. In 1974, another group of 500 varieties were studied for their resistance to Yellow Orange Leaf Virus disease and several were found to be resistant. They also reported that floating ability in rice was a partially dominant character. Five to six genes were assumed to govern this character. Phenotypic correlations between floating ability and plant height were higher than that between floating ability and maturity. There was no significant correlation between floating ability and panicle number.

Recently, seed samples of local collections have been requested by pathologists and entomologists for routine screening to identify resistant varieties to the current diseases and insects. Soil scientists and rice breeders also request a considerable number of varieties to be

grown annually in their screening programs to identify genotypes tolerant to problem soils. Some of the most comprehensive data on reaction to blast and tungro virus has been reported by Praphas Weerapat and his colleagues which have been presented in mimeograph form (Weerapat, 1965 and 1966).

Degree of genetic erosion and plan for field collection

Table 1 and Figure 2 indicate that the past collection originated from nearly all provinces of the country. However, as mentioned before, many varieties in remote areas have never been collected. Upland rice varieties grown by villagers and hilltribes in high mountainous areas have been ignored because of the problem of accessability. At present, no government recommended upland varieties have been released. Thus, it seems safe to say that vast genetic variation in upland rice cultivars still exist.

Genetic variability in lowland and floating rice may face serious deterioration. After the release of government recommended varieties improved by pure line selection, these replaced many local varieties previously grown. Following development of the modern HYV's some farmers in the Central Plain and in other regions with irrigation systems have turned to using these new varieties. Even in areas which formerly grew only floating rice, farmers have changed their cultivation practices. Instead of growing deep water rice in the wet season, they grow only HYV's in the off-season and get higher yields with a shorter growing season. Another factor that may affect loss of germplasm is the construction of many dams, reservoirs, irrigation canals, and new highways. They prevent flooding, control water levels, and decrease water depths. Farmers in these areas will definitely abandon their traditional varieties and seek new ones that fit the new growing environments.

In order to preserve the rice genetic resources, extensive collections should be made again. Areas where few or no seed samples have been collected in the past should receive greater attention. The suggested areas are those in bordoring provinces (Figure 2). Even varieties in areas where the past collections had been done repeatedly still need to be re-collected because many varieties appear only on the list but seed samples are no longer available or are not viable. Those provinces where the HYV's are spreading rapidly must receive high priority to prevent genetic erosion before the local types disappear.

Problems in collection and maintenance

Although the danger of genetic erosion has been recognized for a long time, it is not easy to take action. Many problems need to be solved. The most heavy burdens are funds for travelling, transportation facilities, and personnel for collection and evaluation. Budgets allocated to the Rice Division in the future may not be sufficient. The alternative is to seek cooperation from the Agricultural Extension Department. The most important need is dependable, long term seed storage facilities that can maintain the viability of accessions for many years. This will help to relieve the work of frequent seed regeneration. Finally, well-trained technicians are required to handle genetic stocks.

Table 1. Number of seed samples classified by provinces, endosperm types, and cultural practices collected during the years 1950-1967.

No. Province	Classification					Total
	Endosperm type		Cultural practice			
	Glutinous	Non-glutinous	Upland	Lowland	Floating	
Northern Region						
1. Chiang Mai	174	68	19	222	1	242
2. Chiang Rai	232	99	32	297	2	331
3. Kamphaeng Phet	-	1	-	1	-	1
4. Lampang	269	24	45	248	-	293
5. Lamphun	37	8	-	23	22	45
6. Mae Hong son	11	19	-	30	-	30
7. Nakhon Sawan	4	113	-	101	16	117
8. Nan	85	6	41	50	-	91
9. Phetchabun	8	18	-	26	-	26
10. Phichit	5	85	-	53	37	90
11. Phitsanuloke	-	29	-	20	9	29
12. Phrae	72	13	21	64	-	85
13. Sukhothai	2	55	-	57	-	57
14. Tak	-	6	-	6	-	6
15. Uthai Thani	5	101	-	106	-	106
16. Uttaradit	24	38	-	62	-	62
Northeastern Region						
17. Buri Ram	10	18	-	28	-	28
18. Chaiyaphum	28	14	-	41	1	42
19. Kalasin	64	33	-	95	2	97
20. Khon Kaen	166	120	-	280	6	286
21. Loei	11	-	-	1	10	11
22. Maha Sarakam	55	5	-	57	3	60
23. Nakhon Phanom	119	8	14	113	-	127
24. Nakhon Ratchasima	13	121	13	118	3	134
25. Nong Khai	39	14	8	44	1	53
26. Roi-et	40	20	-	60	-	60
27. Sakon Nakhon	145	19	-	163	1	164
28. Si Sa Ket	40	54	-	92	2	94
29. Surin	10	53	-	63	-	63
30. Ubon Ratchatani	139	16	-	155	-	155
31. Udon Thani	77	40	-	111	6	117

Table 1. (Continued)

No. Province	Classification					
	Endosperm type		Cultural practice			Total
	Glutinous	Non-glutinous	Upland	Lowland	Floating	
Central Plain Region						
32. Angthong	4	48	-	24	28	52
33. Chachoengsao	1	129	-	125	5	130
34. Chai Nat	1	99	-	52	48	100
35. Chanthaburi	-	1	-	1	-	1
36. Chonburi	6	118	-	116	8	124
37. Kanchanaburi	-	19	-	19	-	19
38. Lop Buri	9	198	-	144	63	207
39. Nakhon Nayok	22	189	-	209	2	211
40. Nakhon Pathom	-	166	-	148	18	166
41. Nonthaburi	2	132	-	134	-	134
42. Pathum Thani	98	465	-	552	11	563
43. Phetchaburi	4	136	-	140	-	140
44. Phra Nakhon (Bangkok)	-	113	-	107	6	113
45. Phra Nakhon Si-Ayuthaya	11	270	-	86	195	281
46. Prachin Buri	25	64	-	76	13	89
47. Prachuab Kiri-Khan	-	-	-	-	-	-
48. Ratchaburi	1	206	-	183	24	207
49. Rayong	-	-	-	-	-	-
50. Saraburi	23	101	-	116	8	124
51. Samut Prakan	4	78	-	72	10	82
52. Samut Sakhon	-	50	-	47	3	50
53. Samut Songkram	-	-	-	-	-	-
54. Sing Buri	2	126	-	87	41	128
55. Suphan Buri	-	35	-	24	11	35
56. Thon Buri	4	45	-	46	3	49
57. Trat	-	-	-	-	-	-
Southern Region						
58. Chumphon	-	19	-	19	-	19
59. Krabi	-	13	7	6	-	13
60. Nakhon Si Thammarat	9	178	20	167	-	187
61. Narathiwat	5	57	-	62	-	62
62. Pattani	-	23	-	23	-	23
63. Phang-nga	-	5	-	5	-	5
64. Phatthalung	2	155	-	154	3	157
65. Phuket	-	11	-	11	-	11
66. Ranong	-	4	-	4	-	4
67. Satun	-	15	-	15	-	15
68. Songkhla	2	53	-	55	-	55
69. Surat Thani	1	46	9	38	-	47
70. Trang	1	22	-	23	-	23
71. Yala	1	10	-	11	-	11

Table 2. Numbers of seed samples classified by regions, endosperm types, and cultural practices collected during the years 1950-1967.

Region	Classification					
	Endosperm type		Cultural practice			Total
	Glutinous	Non-glutinous	Upland	Lowland	Floating	
Northern	928	683	158	1366	87	1611
Northeastern	956	535	35	1421	35	1491
Central Plain	217	2788	-	2508	497	3005
Southern	21	611	36	593	3	632
Total	2122	4617	229	5888	622	6739
	(31.5)*	(68.5)*	(3.4)*	(87.4)*	(9.2)*	(100.0)*

* Values in parentheses are percentages of total samples.

Table 3 Numbers of the present accessions according to their endosperm types and cultural practices.

Accession	Classification						
	Endosperm type			Cultural practice			Total
	Glutinous	Non-glutinous	Unknown	Upland	Lowland	Floating	
Local varieties	485 (25.2)*	1337 (69.4)*	105 (5.4)*	289 (15.0)*	1471 (76.3)*	167 (8.7)*	1927 (100.0)*
	-	-	-	-	-	-	1123
Others							3,050

* Values in parentheses are percentages of total local varieties.

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