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Multiplex SSR-PCR Analysis of Genetic Diversity and Redundancy in the Philippine Rice (*Oryza sativa* L.) Germplasm Collection

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Rice germplasm conservation is vital to ensuring the availability of a rich gene pool for future varietal improvement programs. However, with limited resources for gene banking, there is a need to identify and prioritize unique accessions in the PhilRice gene bank for maximum resource utilization. A robust and unequivocal way to identify duplicates is through multiplex SSR-PCR DNA fingerprinting. The present study established the optimal concentrations and reaction conditions for the successful amplification of PCR products using a multiplex panel composed of rice simple sequence repeat (SSR) markers, namely RM312, RM316, RM514 and RM171. The panel was then used to analyze the genetic diversity and identify duplicates among the 427 rice germplasm accessions with similar or identical variety names from the PhilRice genebank. A total of 15 alleles were detected at the 4 SSR loci. The polymorphism information content (PIC) values of the SSR markers were moderately high ranging from 0.459 to 0.643. A dendrogram was constructed using the Dice similarity coefficient and the UPGMA algorithm. The multiplex SSR-PCR panel produced unique profiles of 31 accessions that, being genetically distinct, should be maintained as part of the main collection of the genebank. There were 17 accessions identified as possible redundants having a bootstrap value greater than 95%. Additional SSR and morphological markers will be required to further strengthen the evidence for redundancy, and hence justify removal of unnecessary duplicates from the collection.

Keywords: dendrogram, genebank, multiplex panel, rice germplasm accession, redundants, SSR

INTRODUCTION

Characterization and quantification of genetic diversity is of fundamental interest to plant breeders. It contributes to monitoring germplasm and can also be used to predict potential genetic gains (Chakravarthi and Narayanan 2006). Rice germplasm collection and conservation activities in the Philippines started in the early 1900s when rice breeders in the academe and the Bureau of Plant Industry began keeping seeds of popular traditional varieties with the intention of using them as breeding parentals. The initial collection comprised of 300 traditional varieties that early Filipino breeders had assembled for breeding work. The collection grew with the addition of large anthropological set from the Cordillera areas and later through gifts from provincial agricultural colleges and development centers as well as opportunistic collecting by PhilRice staff. The early collection was turned over to the then newly established International Rice Research Institute (IRRI) in 1962. A duplicate of which was retrieved when Philippine Rice Research Institute (PhilRice) was created in 1985 (Romero 2006). The germplasm collection of the Philippines stored in the PhilRice genebank holds 11,259 collections as of May 2013.

Rice germplasm conservation is a vital activity that ensures the availability of a rich gene pool for future varietal improvement programs. However, with the limited resources such as finite storage, space and low processing and maintenance outlay, there is an urgent need to identify truly unique accessions in the PhilRice Genebank for maximum resource utilization.

The key to the determination of duplicate entries is the availability of a reliable means of detecting genetic differences. Identical passport data such as variety names and geographical origins are commonly used as an indication of duplication but these are in many cases of dubious authenticity. The morphological characterization procedure presently employed in the PhilRice genebank is also inadequate for this purpose because morphological traits represent a narrow portion of the genome and are often strongly influenced by the environment.

The development of DNA marker technology has provided an efficient tool to facilitate plant genetic resources conservation and management. In rice, molecular markers have been used to identify acces-

sions (Olufowote et al. 1997; Virk et al. 1995), to determine the genetic structure and pattern of diversity for cultivars of interest (Akagi et al. 1997; Mackill 1995; Yang et al. 1994; Zhang et al. 1992) and to optimize the assembly of core collections (Schoen and Brown 1995). Compared to morphological analysis, molecular markers can reveal differences among accessions at the DNA level and thus provide a more direct, reliable and efficient tool for germplasm conservation and management (Ni et al. 2002). Several types of molecular markers are available for evaluating the extent of genetic variation in rice and it was shown that duplicate and suspected duplicate accessions can be identified using polymerase chain reaction (PCR) based technique (Ni et al. 2002; Ravi et al. 2003; Lapitan et al. 2007; Kibria et al. 2009; Kumar et al. 2012; Martin et al. 2012; Tabhkar et al. 2012).

The extent of duplication in the PhilRice Genebank is not fully known. This study aimed to assess the efficiency of multiplex SSR DNA fingerprinting in determining the genetic diversity of 427 rice germplasm accessions in the PhilRice genebank, identify accessions with duplicates, and determine the level of DNA polymorphism produced by the multiplexed SSR markers. Resource use efficiency in the genebank will be increased with the removal of duplicate entries in the germplasm collection. The DNA fingerprint will show the genetic relationships among the germplasm materials, and thereby aid breeders in choosing diverse materials for breeding.

MATERIALS AND METHODS

Plant Materials

The 427 rice germplasm accessions used in this study consisted of 372 Philippine traditional varieties, 10 traditional varieties from Iran, 8 accessions from Bangladesh, 7 accessions from Cambodia and Indonesia, 14 accessions from India, 4 accessions from the United States of America, 1 accession from Fiji and 2 accessions from Senegal and Laos. Rice germplasm accessions were obtained from the Rice Genebank at the Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

DNA Extraction

Fifty pure seeds of each accession from the PhilRice Genebank were pre-germinated in Petri dishes for 3 days and were sown in plastic food keepers with soil in the green house. Around 100 mg of young leaves were collected from 3 wk old seedlings of each rice accession. The leaves from each accession were pooled before DNA extraction. Leaf samples were ground in liquid nitrogen using mortar and pestle. DNA was extracted using a modified CTAB DNA extraction protocol (Rogers and Bendich 1988).

Genomic DNA samples were checked for quality on 1.0% agarose gel electrophoresis, and the concentration was estimated against undigested lambda DNA standard (Invitrogen, Carlsbad CA). Electrophoresis

was carried out at 100 V for 2 h. Detection of bands was done in an ethidium bromide staining solution for 15 min.

Design of Multiplex SSR-PCR

Initially, 20 microsatellite markers were selected from previous studies by Filho et al. (2007), Ram et al. (2007) and Thomson et al. (2007) on the basis of their genomic locations, annealing temperature and allele size. The different markers were grouped together to develop multiplex panel on the basis of their allele size range, map location and annealing temperature. The software 'Amplify' for PCR experiments was used to ensure no formation of primer dimers within the different markers in each multiplex panel, which could hamper legitimate amplification of target loci. In each panel, markers with different allele size range were assigned to avoid overlapping bands during gel analysis. In order to obtain completely unambiguous multiplex genotyping, it was important to optimize the combination of primers used. One multiplex panel was assembled that contain 4 primer pairs based on their allele size and optimal annealing temperature. The PCR conditions were optimized by testing different primer concentrations, dNTPs, MgCl₂, amounts of DNA template and *Taq* DNA polymerase to equalize signal strength for each panel. The multiplex panel set was tested several times to ensure reproducibility. The optimum PCR cocktail is shown in Table 1.

PCR was run in a 96-well thin walled polycarbonate v-bottom microtiter plate (Costar, Corning Inc., New York, USA) on a programmable thermal cycler (MJ Research PTC-100). PCR products were fractionated through electrophoresis on 8% non-denaturing polyacrylamide gel for 2 h. The gels were stained with ethidium bromide for 20 min and then observed under ultraviolet illumination. The PCR profile is shown in Table 2.

Data Analysis

Polymorphic bands were scored as "1" for presence and "0" for absence. Genetic similarity was calculated as Dice coefficient using the SIMQUAL module in Numerical Taxonomy and Multivariate Analysis (NTSYS), Version 2.0 (Rohlf 1993). Polymorphism information content (PIC) was calculated using the formula by Weir (1996):

$$PIC = 1 - (\sum p_i^2)$$

where p_i is the frequency of the i th allele of an SSR marker, and \sum is the summation over the total number of alleles for that marker.

Construction of Dendrogram

The similarity coefficients were used to construct a dendrogram by Unweighted Pair Group Method with Arithmetic Mean (UPGMA) (Sneath and Sokal 1973) as implemented in NTSYS. Bootstrapping of the UPGMA tree was performed using Winboot program (Yap and Nelson 1996) with 2,000 iterations.

Table 1. Polymerase chain reaction components

Components	Volume (μ L)	Final Concentration
Sterile distilled water	2.06	-
10 X PCR buffer	0.75	1X
10 mM MgCl ₂	1.5	2 mM
2.5 mM dNTP	0.69	0.23 mM
10 μ M forward primer	0.5	0.67 μ M
10 μ M reverse primer	0.5	0.67 μ M
Taq polymerase	0.5	-
DNA	1	-
TOTAL	7.5	

Table 2. PCR profile of multiplex genotyping

Step	Temperature ($^{\circ}$ C)	Time (min)
1	94 – initial denaturation	5
2	94 - denaturation	1
3	55 - annealing	1
4	72 – primer extension	2
5	35 cycles to step 2	
6	72 – final extension	5
7	15 - soaking	

Optimization of Multiplex-SSR PCR

In this study, multiplex PCR with SSR markers was used for DNA fingerprinting of rice germplasm. Multiplex-PCR involves more than a pair of primers acting independently. It allows the simultaneous analysis of multiple targets in a DNA sample without having to prepare many individual reactions.

The optimization of multiplex PCR can pose several difficulties, including poor sensitivity or specificity and preferential amplification of certain specific targets. The presence of more than one primer pair in the multiplex PCR increases the chance of obtaining spurious amplification products, primarily because of the formation of primer dimers. Despite the difficulties in optimizing multiplex PCR, it has the potential to bring considerable savings in time and effort once the optimal procedure is carried out for numerous samples on a routine basis.

This panel consisting of four SSR markers (RM312, RM316, RM514 and RM171) yielded the optimum PCR products. The other multiplex panels did not produce the target composite bands of the component markers at the various primer concentrations tested. Multiplex products run on 8% non-denaturing polyacrylamide gel can be gleaned from Figure 1. The

amplicons produced were clear and easy to score. Hence, the multiplex panel consisting of four SSR markers was used for assessing genetic diversity among the 427 rice germplasm accessions. Table 3 describes the four SSR markers used in the multiplex panel and the data on the number of alleles scored and polymorphic information content (PIC). The multiplex panel produced a total of 15 alleles from 427 genotypes. The number of alleles for RM312, RM316, RM171 were 4, 5 and 3 respectively. The PIC values which reflect the robustness of the marker were 0.643 for RM312, 0.598 for RM316, 0.576 for RM514 and 0.459 for RM171.

The polymorphism information content is an estimate of the discriminatory power of an SSR marker (Ram et al. 2007), and is extremely useful in distinguishing the polymorphism rate of a marker at a specific locus (De Woody et al. 1995). Markers with PIC values of 0.5 or higher are highly informative. The robustness of the SSR markers is due to their good PIC values ranging from 0.459 to 0.643.

The observed PIC values are comparable to previous studies. Jain et al. (2003) used four multiplex panels consisting of 30 fluorescent-labeled SSR markers to study the genetic diversity and phylogenetic relationships among the aromatic high quality rice germplasm collections from different parts of India. RM 312 and RM171 were part of one of the multiplex panels together with RM105, RM133, RM103, RM282 and RM337. The PIC values of RM312 and RM171 were 0.558 and 0.732 respectively. Another study by Coburn et al. (2002) noted that RM171 is highly variable at both the inter and intra subspecific levels, making it very useful for distinguishing closely related genotypes. Thomson et al. (2007) characterized 330 rice accessions using multiplex panels of 30-fluorescently-labeled microsatellite markers, where RM514 showed a PIC value of 0.71. RM316 was used by Ravi et al. (2003) to assess the genetic diversity among 40 cultivated varieties and five wild relatives of rice. It yielded a PIC value of 0.581.

SSR markers exhibited high PIC values because of their codominant expression and multiallelism (Ram et al. 2007). The lower PIC values of the four markers on average in this study maybe due to the narrower genetic pool of the samples arising from redundant accessions. The considerably low PIC value of RM171 in this study may be due to the poorer resolution of its large alleles on polyacrylamide gel compared to the other methods. Nevertheless, the four markers were able to detect possible redundant accessions based on bootstrap analysis which already established a number of unique accessions.

Cluster Analysis

The similarity matrix representing the Dice coefficient was used to cluster the data using the UPGMA algorithm. Analysis of the 427 rice germplasm accessions revealed 48 clusters with 100% similarity coefficients (cluster results of the dendrogram is shown in Appendix Table 1). Accessions with similar names

Table 3. Simple sequence repeats (SSR) markers with forward and reverse primer sequences and data on number of alleles and polymorphism information content (PIC)

SSR markers	Forward Primer	Reverse Primer	Number of Alleles	PIC Values
RM312	5'GTATGCATATTTGATAAGAG3'	5'AAGTCACCGAGTTTACCTTC3'	4	0.643
RM316	5'CTAGTTGGGCATACGATGGC3'	5'ACGCTTATATGTTACGTCAAC3'	5	0.598
RM514	5'AGATTGATCTCCCATTCCCC3'	5'CACGAGCATATTACTAGTGG3'	3	0.576
RM171	5'AACGCGAGGACACGTACTTAC3'	5'ACGAGATACGTACGCCTTTG3'	3	0.459
TOTAL			15	

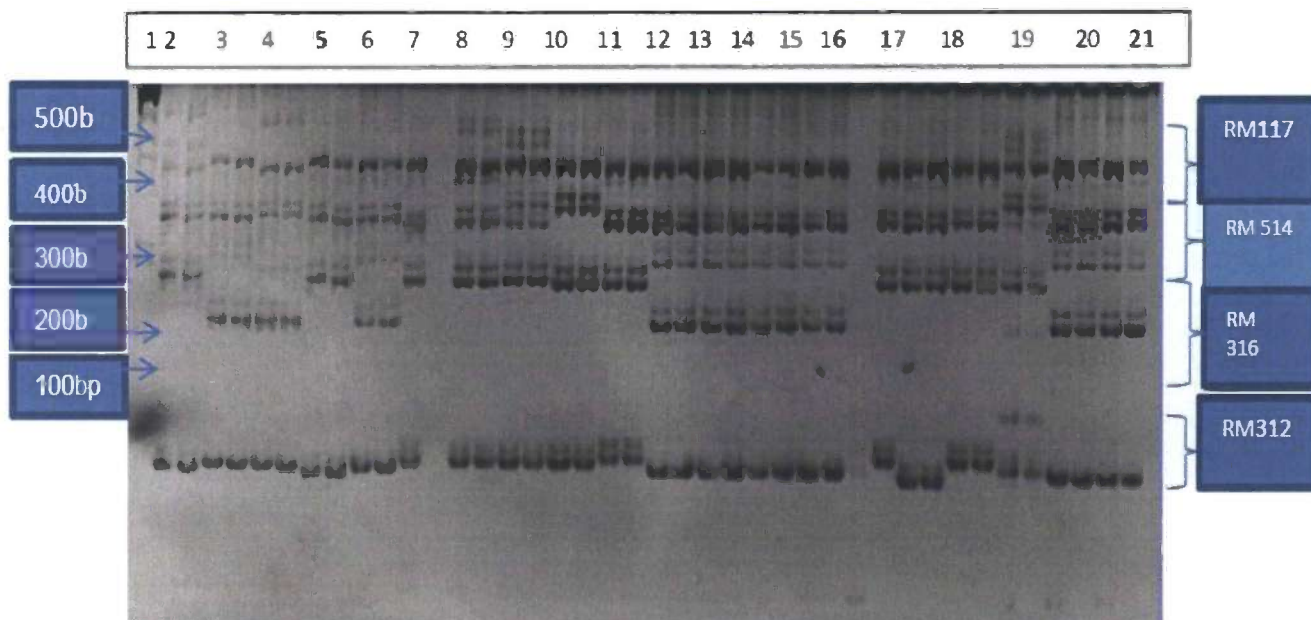


Figure 1. Multiplex PCR panel with RM312, RM316, RM514, RM117 loci on 8% non-denaturing Polyacrylamide gel. Lane 1 100 bp DNA ladder; Lanes 2-21 PCR products from the DNA of 20 replicated accessions

and of genetically similar type clustered together. There are 31 accessions that clustered individually and separately from other groups indicating that they are unique accessions (Appendix Table 2).

Efforts should be expected and priority given to unique accessions for conservation purposes. Although, unique accessions have similar names, they should be maintained in the gene bank to conserve their genetic make-up for use in varietal improvement in the future. The knowledge of within-accession variability is important for conservation purposes because it is possible to determine the most genetically variable accessions which would demand an additional effort of sampling a higher quantity of seeds in order to preserve genetic variability (Brondani et al. 2006).

In order to test the robustness of the clusters in the dendrogram, bootstrapping with the software package Winboot was used. A bootstrap confidence value of 95% or greater was considered significant. Possible redundants were identified based on the bootstrap analysis having a confidence level greater than 95%. Passport data and acquisition history supported the bootstrap analysis. Identification of redundant accessions is important to increase the efficiency of

resource use in genebanks. For storage purposes, only a representative of each duplicate is necessary. From a purely management point of view, there are distinct advantages in trying to identify duplicate accessions and thereby conserving only the collection of unique genetic materials (Virk et al. 1995). Table 4 shows the Philippine rice accessions with bootstrap values greater than 95%.

Bootstrapping of the clusters revealed that PRRI-000259 Binangkuro (IRGC 44326), PRRI000909 Binangkuro (96- OCM 18) and PRRI000910 Binangkuro (96- OCM 19) of cluster 1 has a confidence value of 100%. The three Binangkuro accessions originated from the same province which is Occidental Mindoro. Therefore, it can be deduced that the three Binangkuro accessions (PRRI000259, PRRI000909 and PRRI000910) are possible redundants. Two other Binangkuro accessions yielded 99.6% confidence value: PRRI003441 Binangkuro (2003-01-01-102) and PRRI000918 Binangkuro (96- OCM 37). This Binangkuro accession is most likely a naming error from Binangkuro when it was introduced in Palawan presumably from Mindoro.

Other accessions that yielded a confidence value of 100% making them possible redundant accessions

are: PRRI003452 Binuhangin (97-SDS 64) and PRRI000649 Binuhangin (96-OCM5); Bintalan accessions (PRRI000919 and PRRI003451) both from Occidental Mindoro; and from Palawan are Bolig-bolig accessions; PRRI003971 Bolig-bolig (2004-02-01-06) and PRRI003972 Bolig-bolig (2004-02-01-03). PRRI002478 Banate2 (IRGC109310) and PRRI000849 Banate (IRGC 81724) had a confidence value of 99.6%. Both accessions originated from Iloilo and both are *indica* subspecies. Two accessions of *O. glabberima* that originated from Senegal which are CG-14 TML41 and CG-14 yielded a 98.6% confidence value, indicating that the two accessions are indeed similar. PRRI000488 Balatinaw (IRGC 12050) and PRRI002472 Balatinaw (IRGC 44297) had a confidence value of 98.3%. Both these accessions originated from the Mountain Province.

Some rice germplasm accessions are clustered individually and are separate from other groups (Appendix Table 2). PRRI0003520 Diket (98-QUI 16) and PRRI0003521 Diket (98-QUI 20) both from the province of Quirino and both of *javanica* subspecies are clustered individually. One Binangkuro accession which is PRRI000442 Binangkuro (Balayang) (IRGC 44292) from Ilocos Norte is clustered separately from the major cluster where majority of Binangkuro accessions are grouped together (Appendix Table 1), raising doubts over its name. PRRI002763 Burean (aromatic) and PRRI002268 Bureau are also found as separate clusters. Cluster analysis also separated one accession of *javanica* Azucena, PRRI002234 Azucena 1 from the rest of the *indica* Azucena accessions.

Three Basmati accessions: PRRI000965 Basmati narot 493, PRRI000969 Basmati 5851 and PRRI0004402 Bashmoti (D) clustered individually and separately from the other Basmati accessions. Other accessions that were clustered individually are the following: PRRI002997 Bayabas (IRGC19385), PRRI002171 Batangas mixture (Ginit-an), PRRI00265 Kinandang puti, PRRI002269 Kinanda, PRRI002609 China rice, C22, PRRI002190 Binig-it, PRRI001847 Burik, PRRI005322 Binuhangin (IRGC 67430), PRRI003126 Benerhin (IRGC 44311), C22, PRRI000729 Sigadis milagrosa, PRRI000923 Binibe (96-OCM 49), PRRI001968 C22, Brown gora TML 40, C22, Chinsurah boro 2 (IRGC 11760), BPI R1 10 TML 40, PRRI004512 Diamante (IRGC 44393), PRRI002213 Eurian, PRRI001919 Batangas mixture (minantika) and PRRI000778 Cambodia 3 (FC 14) (Appendix Table 2). These results suggest that accessions which are clustered separately from the major groups represent a unique genetic make-up. Although, some have similar variety names, they should be regarded as unique accessions and thus should be accorded equal attention and resources for conservation purposes to ensure long term survival.

Due to the fact that only one multiplex panel was optimized with four SSR markers, it is still possible that the genetically identical materials based on DNA profiling can be different; hence, they should be considered probable duplicates only. Nevertheless,

Table 4. List of the Philippine rice accessions with bootstrap confidence values greater than 95%

No.	Accession	Variety	Boot-Strap Values
1	PRRI000259	BINANGKURO (IRGC 44326)	
2	PRRI000909	BINANGKURO (96-OCM 18)	100%
3	PRRI000910	BINANGKURO (96-OCM 19)	
280	PRRI000919	BINTALAN (96-OCM 42)	
281	PRRI003451	BINTALAW (2003-11-01-04)	
282	PRRI000649	BINUHANGIN (96-OCM5)	
283	PRRI003452	BINUHANGIN (97-SDS 64)	100%
287	PRRI003971	BOLIG-BOLIG (2004-02-01-03)	
288	PRRI003972	BOLIG-BOLIG (2004-02-01-06)	
5	PRRI003441	BINANGKURO	
6	PRRI000918	(2003-01-01-102)	99.60%
253	PRRI002478	BINANGKURO (96-OCM 37) BANATE 2 (IRGC 109310)	
254	PRRI000849	BANATE 1 (IRGC 81724)	99.60%
332	-----	CG-14 TML 41	
333	-----	CG-14	98.60%
103	PRRI002472	BALLATINAW (IRGC 44297)	
101	PRRI000488	BALATINAW (IRGC 12050)	98.30%

the panel produced unique profiles of 31 accessions out of 427 or 7.25% of the materials. These accessions are therefore genetically distinct and should be maintained as part of the main collection of the genebank.

CONCLUSIONS AND RECOMMENDATIONS

DNA fingerprinting using multiplex-SSR PCR with four markers produced good amplification products in a large collection of germplasm materials inferred to be mostly redundant entries due to their similar variety names. Cluster analysis with the UPGMA algorithm was used to group the germplasm accessions into a dendrogram that provided a complete perspective of their genetic relationships. Accessions sharing the same branch at $S=1.0$ are considered probable redundants. After bootstrapping, accessions registering 100% confidence within each branch at $S=1.0$ are highly probable redundants. A grow-out test of these

accessions planted side-by-side will be the final arbiter for deciding on their duplicate nature. For materials with less than 100% confidence level, additional 3-5 SSR markers for DNA profiling are recommended to further reliably determine if the materials are unique or duplicates. In conclusion, the allelic diversity revealed by multiplex PCR consisting of four SSR markers serves as baseline information of the genetic diversity of the 427 rice germplasm accessions. Further optimization of more SSR primer pairs in a multiplex-PCR is recommended for more definitive separations or support of clusters of genotypes.

While multiplex PCR clearly enhances the efficiency of SSR markers, there is, however a trade-off between the investment in labour and resources to establish this method and the time saved by the need to run fewer gels. The methodology developed will be useful to study the levels and patterns of genetic diversity in rice germplasm collections, where a large number of accessions and genotypes need to be fingerprinted.

In this study, manual system was used for the development of multiplex SSR-PCR panels. For high throughput fingerprinting of rice germplasm accessions and assaying genetic diversity, it is recommended to use the Geneflow software in designing multiplex panels. Fragment sizing analysis with GeneScan and Beckman's Fragment Analysis is also recommended. The panels of microsatellite markers should greatly expedite genotyping. Many more markers can be assembled for use in diversity studies. The ability to assemble multiplex combinations will greatly improve the efficiency of genetic analysis. Since optimization of multiplex SSR-PCR is time consuming, it is also recommended that manpower should be doubled especially when the samples are rice germplasm collection from a genebank.

A follow-up study of the comparative analysis of morphological characteristics is highly recommended to consistently confirm if indeed the accessions were redundant. For the identification of duplicates of rice germplasm accessions, a prior knowledge of morphological characters of duplicates is recommended mainly for comparison purposes. However, care must be taken when utilizing morphological data for they are subject to variation caused by the environment.

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Appendix Table 1. List of 48 clusters of Philippine rice accessions with 100% similarity coefficients, including passport data and key

CLUSTER 1									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	Plant Height (cm)	Ave. No. of Panicle/Plant
1	PRR1000259	Binangkuro (IRGC 44326)	Indica	Occ. Mindoro	White	Spindle	2.5-2.99	159.42	13
2	PRR1000909	Binangkuro (96-OCM 18)	Indica	Occ. Mindoro	-----	-----	-----	-----	-----
3	PRR1000910	Binangkuro (96-OCM 19)	No Data	Occ. Mindoro	White	Half-spindle	2.0-2.49	175.70	4
5	PRR1003441	Binangkudo (2003-01-01-102)	No Data	Palawan	White	Half-spindle	2.0-2.49	-----	12
6	PRR1000918	Binangkuro (96-OCM 37)	Indica	Occ. Mindoro	White	Half-spindle	2.0-2.49	141.36	17
9	PRR1000804	Belibod na Pula	Indica	Quezon	White	-----	-----	121.00	-----
13	PRR1000630	Balibod (96-QZN 50)	No Data	Quezon	White	-----	-----	143.20	-----
21	PRR1000855	Bulibod na Puti	Indica	Quezon	-----	Semi-round	1.5-1.99	109.20	15
22	PRR1002879	Bolbod (IRGC 52865)	Indica	Cam. Sur	-----	-----	-----	-----	-----
415	PRR1005331	FK 178 A (IRGC 298)	Indica	Ilocos Sur	-----	-----	-----	172.20	-----
42	PRR1000661	Binato (96-OCM 31)	Indica	Occ. Mindoro	White	-----	-----	-----	-----
46	PRR1000829	Binato	Indica	Indica	-----	-----	-----	-----	-----
48	PRR1000917	Binato (96-OCM 33)	Indica	Occ. Mindoro	White	-----	-----	118.00	-----
49	PRR1000921	Binato (96-OCM 46)	Indica	Occ. Mindoro	-----	-----	-----	152.10	-----
58	PRR1000967	Basmati C 622	Indica	India	White	Long spindle	≥3.0	139.74	14
59	PRR1000970	Basmati 372	Indica	India	White	-----	-----	170.60	-----
61	PRR1000963	Basmati 123	Indica	India	White	Long spindle	≥3.0	140.20	27
95	PRR1001756	Awot	Indica	S. Cotabato	White	-----	-----	105.38	-----
105	PRR1000648	Binagimbin (96- OCM 4)	Indica	Occ. Mindoro	Purple	-----	-----	124.00	-----
107	PRR1003475	Bulaw (IRGC 11290)	Indica	N. Vizcaya	-----	-----	-----	-----	-----
125	PRR1002483	Bangitan (98- PAL 17)	Indica	Palawan	Light Brown	-----	-----	-----	-----
137	PRR1002194	Dumali	Indica	Antique	-----	-----	-----	-----	-----
139	PRR1001869	Bihod	No Data	Iloilo	White	-----	-----	-----	-----
141	PRR1003483	Busiyetan (IRGC 11205)	Javanica	N. Vizcaya	White	-----	-----	-----	-----
142	PRR1003484	Busiyetan (IRGC 11312)	Javanica	N. Vizcaya	-----	-----	-----	-----	-----
145	PRR1002192	Binakayo	Indica	Pampanga	-----	-----	-----	-----	-----
381	PRR1001821	Dinorado B 1997 DS- 136	No Data	Agusan del Sur	Light Brown	-----	-----	-----	-----
246	PRR1000631	Camoros (96-QZN 52)	No Data	Quezon	Light Brown	-----	-----	-----	-----
247	PRR1000667	Camuros (96- OCM 48)	Indica	Occ. Mindoro	Mixture	-----	-----	-----	-----
248	PRR1004495	Camoros (2004-02-01-40)	No Data	Palawan	-----	-----	-----	-----	-----
327	-----	Cambodia 3 (FC 14)	No Data	Cambodia	-----	-----	-----	-----	-----
338	PRR1005294	Cina Mee (IRGC 6693)	Indica	Fiji	-----	-----	-----	158.20 cm	22
342	PRR1001787	DA Var A	No Data	No data	-----	-----	-----	-----	-----

CLUSTER 2

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
8	PRR1003442	Binangkudo	No data	Palawan					
37	PRR1003269	Binalasang (IRGC 47149)	Indica	Apayao					
128	PRR1002494	Basilanen (IRGC 19384)	Indica	Palawan					
133	PRR1003448	Bineggit (IRGC 11300)	Javanica	N. Vizcaya	Light Brown			149.24	14
136	PRR1001928	Dumali	No Data	Batangas	White	Half-spindle	2.0-2.49	118.2	16
143	PRR1000092	Binotete (IRGC 44339)	Indica	Ilocos Norte					
173	PRR1002255	Kinandang Pula	No Data	Batangas					
175	PRR1002936	Kinanda (IRGC 4015)	No Data	No data					
178	PRR1000877	Kinandang Puti	Indica	Batangas	White			123	
195	PRR1002422	Ambol (IRGC 52990)	Indica	Cagayan	White			182.4	
221	PRR1003224	Milagrosa (IRGC 44636)	Indica	Pangasinan					
226		Milagrosa (IRGC 44635)	Indica	No Data					

CLUSTER 3

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
43		Binato (96-OCM 39)	Indica	Occ. Mindoro	White			134.6	
245	PRR1000668	Camoros (96- OCM 54)	Indica	Occ. Mindoro	White			149.84	
44	PRR1000662	Binato (96-OCM)	Indica	Occ. Mindoro	Light Brown			135	

CLUSTER 4

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
50	PRR1003446	Binato (2003-11-01-03)	Indica	Occ. Mindoro					
392	PRR1003153	Dinolores (IRGC 44403)	Indica	Ilocos Norte					
210	PRR1005107	Antipolo (1999-09-01-22)	Indica	Abra					
208	PRR1001754	Anglad	Indica	Palawan		Half-spindle	2.0-2.49	161	13
204	PRR1003151	Diket (Anangka)	Indica	Ilocos Norte					
203	PRR1000417	Americano (IRGC 64168)	Indica	Palawan				138.6	14.2
211	PRR1002454	Antipolo (IRGC 47095)	Indica	Pampanga					
209	PRR1002452	Anglad (2003-01-01-047)	Indica	Palawan					
188	PRR1003186	Kinandang Puti	Indica	Or. Mindoro					
189	PRR1002414	Alabang (354)	Indica	No Data					
187	PRR1002989	Ginanda (IRGC 16917)	Indica	Bulacan					
158	PRR1002998	Binagacay (IRGC 19389)	Indica	Palawan					
167	PRR1002980	Kinandang Puti	Indica	No Data					
174	PRR1002891	Kinandang Pula	Japonica	No Data					
238	PRR1002261	Camoros	No Data	Batangas	White				
63	PRR1003436	Basmati 370	Indica	India					
239	PRR1003116	Camorus (IRGC 30332)	Indica	Antique					
164	PRR1002782	Kinandang Pula	Indica	Batangas	Light Brown				
91	PRR1002456	Arabon	Indica	Zamboanga	White			90.07	

Appendix Table 1. Continued

CLUSTER 5									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
87	PRR1002942	Binirhen (IRGC 4022)	Indica	No Data	White	Spindle	2.5-2.99	143.74	24
180	PRR1002776	Kinanda	Indica	Batangas	Red				
255	PRR1000520	Sa-Igorot (IRGC 44725)	Javanica	La Union					
130	PRR1003423	Basilanin (2003-01-01-1)	No Data	Palawan					
256	PRR1005287	Sa-Igorot (IRGC 44727)	Javanica	La Union	Light Brown			162.4	
168	PRR1002256	Kinandang Puti	Indica	Batangas	White			122.6	
169	PRR1003085	Kinandang Patong	Indica	Batangas				133.2	
120	PRR1003339	Carabao (IRGC 52885)	Indica	Zamboanga					
129		Basilanen (IRGC 19384)	No Data	Palawan					
90	PRR1000181	Arabon (Glut)	Indica	Nueva Ecija	White	Long-spindle	≥3.0	149.62	
88	PRR1002887	Binirhen (IRGC 3809)	Indica	No Data					
89	PRR1002425	Arabon (97-BHL 14)	Javanica	Bohol)	White				
CLUSTER 6									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
123	PRR1003376	Bungkitan (IRGC 53000)	Indica	Iligao					
124	PRR1001980	Bongkitan	Indica	Cagayan					
CLUSTER 7									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
163	PRR1002916	Kinandang Inuzo	Japonica	No Data					
179	PRR1002869	Kinandang Pula	Javanica	No Data	White			147.58 cm	14
CLUSTER 8									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
14	PRR1000621	Balibod (96-QZN 38)	No Data	Quezon					
421	PRR1003988	Gal-it (98- ABR 28)	Indica	Abra					
417	PRR1003008	Fortuna (IRGC 19401)	Indica	Palawan					
56	PRR1000962	Basmati 370 A	Indica	India	White	Long-spindle	≥3.0	165.3	25
70	PRR1000669	Azucena (96-OCM 55)	Indica	Occ. Mindoro	White			141	
94	PRR1000210	Arimongmong	Indica	Nueva Ecija	White			144.52	30.8
99	PRR1000744	Awot (96 ANT 12)	Indica	Antique	White			135.78	
110	PRR1003123	C 22 (C22-51)	Hybrid	Laguna					
273	PRR1003131	Binastian (IRGC 44327)	Indica	No Data					
274	PRR1000444	Binignay (IRGC 44334)	Indica	Occ. Mindoro		Half-spindle	2.0-2.49	133.88	19.4
291	PRR1001850	BPI	Indica	Cagayan	Light Brown			123.32	
288					White			131.5	15
287	PRR1003971	Bolig-Bolig	No Data	Palawan	White	Half-spindle	2.0-2.49	114.14	13
280	PRR1000919	Bintalan (96 -- OCM 42)	Indica	Occ. Mindoro					

CLUSTER 8									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
283	PRRI003452	Binuhangin(97-SDS 64)	Indica	Surigao del Sur	Red	-----	-----	-----	11
282	PRRI000649	Binuhangin (96- OCM 5)	No Data	Occ. Mindoro	White	Half-spindle	2.0-2.49	-----	12
281	PRRI003451	Bintalaw (2003)	No Data	Palawan	Speckled Brown	Semi-round	1.5-1.99	-----	13
CLUSTER 9									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
268	PRRI000040	Bandera (IRGC 5168)	Indica	Nueva Ecija	-----	-----	-----	-----	-----
411	PRRI000005	Eruian (IRGC 5254)	Indica	Nueva Ecija	-----	-----	-----	-----	-----
CLUSTER 10									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
171	PRRI002944	Eruian (IRGC 5254)	Indica	No Data	-----	-----	-----	-----	-----
422	PRRI004533	Galit (98- ABR 1)	Indica	Abra	-----	-----	-----	-----	-----
418	PRRI003550	Fortuna (98-PAL 50)	Indica	Palawan	-----	-----	-----	-----	-----
410	PRRI005398	Inanod (IRGC 24235)	Indica	Mountain Prov.	White	-----	-----	177.2	-----
368	PRRI000277	Decola (IRGC 44392)	Indica	Pangasinan	White	-----	-----	137.65	-----
354	-----	Digha (IRGC 26331)	Indica	Bangladesh	-----	-----	-----	-----	-----
367	PRRI000225	Dicula (IRGC 36729)	Indica	Pangasinan	White	-----	-----	142	-----
184	PRRI002909	Kinandang Polopot	Indica	No Data	-----	-----	-----	107	-----
405	PRRI000024	Ennana (IRGC44411)	Indica	La Union	-----	-----	-----	-----	-----
235	PRRI003811	Milagrosang Puti	Indica	Catanduanes	-----	-----	-----	-----	-----
403	PRRI003159	Ilon-ilon	Indica	Basilan	White	Long-spindle	≥3.0	93.36	29
261	PRRI000873	C-1	No Data	Batangas	White	-----	-----	124.4	-----
426	PRRI005274	Gallano (IRGC 44422)	Indica	Ilocos Norte	-----	Long-spindle	≥3.0 mm	194.7	9
387	PRRI003528	Dinorado(CMU-Bukidnon	No Data	Bukidnon	-----	-----	-----	-----	-----
236	PRRI000720	Milagrosa (Tall)	No Data	Nueva Ecija	White	-----	-----	156.2	-----
232	PRRI003809	Milagrosang Puti	Indica	Catanduanes	-----	-----	-----	-----	-----
CLUSTER 11									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
32	PRRI003480	-----	No Data	Occ. Mindoro	-----	-----	-----	-----	-----
408	PRRI001903	-----	Indica	Nueva Ecija	-----	-----	-----	146	-----
207	PRRI005103	-----	Indica	Iran	White	Long-spindle	≥3.0	132.72	27
257	PRRI000378	-----	Indica	Kalinga/Apayao	Light Brown	-----	-----	145.56	-----
407	PRRI000479	-----	Indica	La Union	White	-----	-----	-----	-----
79	-----	-----	Indica	No Data	-----	-----	-----	-----	-----
80	-----	-----	Indica	No Data	-----	-----	-----	-----	-----
81	-----	-----	Indica	No Data	-----	-----	-----	-----	-----
82	PRRI003132	-----	Indica	No Data	-----	-----	-----	-----	-----

Appendix Table 1. Continued

CLUSTER 11							
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Ave. No. of Panicle/Plant
122	PRR100256	Bangkitan	Indica	No Data	Purple		
CLUSTER 12							
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Ave. No. of Panicle/Plant
71	PRR1002437	Azucena (IRGC 47124)	Indica	Bukidnon			
359	PRR1001586	Digul	No Data	Indonesia			
CLUSTER 13							
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Ave. No. of Panicle/Plant
40		Balasang (IRGC 44291)	Indica	Ilocos Norte	Red		
348	PRR1003514	Demil (IRGC 19399)	Javanica	Nueva Vizcaya		Half-spindle	134.9
349	PRR1003515	Demmil (IRGC 11277)	Indica	Nueva Vizcaya		Spindle	141.56
73	PRR1002439	Azucena (IRGC 52992)	Indica	Ifugao			
369	PRR1001808	Decola	Hybrid	Nueva Vizcaya	White		114.6
275	PRR1003270	Bugnay (IRGC 47152)	No Data	Apayao	White		
92	PRR1000252	Aribongbong Alog	Indica	La Union	White		
93	PRR1002426	Aribungbong	Indica	Cagayan	White		117.24
258	PRR1000460	Buwoo-wa (IRGC 50388)	Javanica	Kalinga/Apayao	Red		
CLUSTER 14							
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Ave. No. of Panicle/Plant
101	PRR1000488	Balatinaw (IRGC 12050)	Javanica	Mountain Prov.	Purple		
103	PRR1002472	Ballatinaw (IRGC 44297)	Indica	Ifugao	Purple	Semi-round	1.5-1.99
CLUSTER 15							
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Ave. No. of Panicle/Plant
185	PRR1002253	Kinandang Pula	Hybrid	Batangas	White		117.26
375		Dinorado	No Data	No Data			
409	PRR1003167	Innanao (IRGC 44470)	Indica	Ilocos Sur			
CLUSTER 16							
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Ave. No. of Panicle/Plant
183	PRR1002164	Kinandang Pula	No Data	Batangas	White		107
416	PRR1005332	FK 178 A (IRGC 299)	Indica	No Data	White		161.6
386	PRR1003117	Dinorado (IRGC 30333)	Indica	Davao del Norte			
419		Gabura (IRGC 26343)	Indica	Bangladesh			178
329		Cambodia 3 Mix	No Data	Cambodia			
335	PRR1005371	Chao-Kao (IRGC 12876)	Javanica	Laos	White		148.4
334	PRR1005369	Chao-Khao	Indica	Laos	White		171.94

CLUSTER 17									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
290									
328		Cambodia 4 (FC 15)	No Data	Cambodia					
CLUSTER 18									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
343	PRR1001788	DA Var E	No Data	No Data	Light Brown				
406	PRR1000025	Ennano (IRGC 44411)	Indica	Pangasinan	White				
402	PRR1003542 B	E2- 227	No Data	Pakistan					
400	PRR1003542	E2- 227	No Data	Pakistan			76.88		
398	PRR1005415	Domsiah (IRGC 32292)	Indica	Iran	White		149.1		
396	PRR1000978	Domsiah	No Data	Iran	White		150.4		
394	PRR1000939	Dom Noub Sor	No Data	Cambodia	White				
382	PRR1002565	Dinurado	No Data	Camarienes Sur					
374	PRR1000281	Dinominga	Indica	Ilocos Norte					
379	PRR1000976	Dinorado (White)	No Data	Nueva Ecija	Light Brown		177.34		
373	PRR1000280	Dinominga	Indica	La Union	White				
401	PRR1003542	E2-227	No Data	Pakistan					
399	PRR1005416	Domsiah (IRGC 32293)	Indica	Iran	White		160.04		
397	PRR1005413	Damsiah (IRGC 32290)	Indica	Iran	White		163.5		
395		Domsian (IRGC 3512)	Indica	Iran	White		178.6		
393	PRR1000774	Dom Naucht (FC 6)	No Data	Cambodia					
391	PRR1002245	Dinolores	No Data	Quezon	White		170.8		
CLUSTER 19									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
7	PRR1000912	Binangkuro	No Data	Occ. Mindoro	White		123		
65	PRR1001859	Azucena	No Data	S. Cotabato	White				
CLUSTER 20									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
10	PRR1000394	Bangkoro	Indica	Benguet	Light Brown		2.5-2.99	173.16	
425	PRR1005272	Gallano(IRGC 44418)	Indica	Ilocos Norte		Spindle			
404	PRR1003545	Elon-Elon(98- SDN 4)	Indica	Surigao del Norte					
97	PRR1002433	Awot	Indica	Antique					
112	PRR1001969	C 22	Indica	No Data	White	Spindle	2.5-2.99	143.98	18

Appendix Table 1. Continued

CLUSTER 20									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
10	PRR1000394	Bangkoro (IRGC 53132)	Indica	Benguet	Light Brown	-----	-----	173.16	-----
425	PRR1005272	Galiano (IRGC 44418)	Indica	Ilocos Norte	-----	Spindle	2.5-2.99	170.20	11.8
404	PRR1003545	Elon-Elon (98-SDN 4)	Indica	Surigaodel Norte	-----	-----	-----	-----	-----
97	PRR1002433	Awot	Indica	Antique	-----	-----	-----	-----	-----
112	PRR1001969	C 22	Indica	No Data	White	Spindle	2.5-2.99	143.98	18
113	PRR1002812	C 22 (IRGC 50)	Indica	Laguna	-----	-----	-----	-----	-----
114	-----	C 22	Indica	No Data	-----	-----	-----	-----	-----
118	-----	C 22	Indica	No Data	-----	-----	-----	-----	-----
119	-----	C 22	Indica	No Data	-----	-----	-----	-----	-----
191	PRR1000249	Alaminos (IRGC 44268)	Indica	Ilocos Norte	White	-----	-----	-----	-----
192	PRR1000086	Aluminos (IRGC 44269)	Indica	Ilocos Norte	White	-----	-----	-----	-----
193	PRR1002420	Aluminos	Indica	Ilocos Norte	White	-----	-----	150.48	-----
198	-----	-----	-----	-----	White	-----	-----	-----	-----
205	-----	Canilangka	Indica	No Data	-----	-----	-----	-----	-----
213	PRR1001797	Milagrosa	No Data	No Data	-----	-----	-----	-----	-----
253	PRR1002478	Banate 2	Indica	Iloilo	White	-----	-----	-----	-----
254	PRR1000849	Banate 1 (IRGC 81724)	Indica	Iloilo	Light Brown	-----	-----	159.80	16.2
262	-----	C-1	No Data	No Data	-----	-----	-----	-----	-----
CLUSTER 21									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
102	PRR1001006	Ballatinao (96-ABR 19)	Indica	Abra	Brown	-----	-----	164.70	-----
372	PRR1000047	Dinominga (IRGC 5187)	Indica	La Union	-----	-----	-----	-----	-----
370	PRR1003525	Dinarunan (IRGC 11206)	Javanica	Nueva Vizcaya	White	-----	-----	130.20	-----
301	PRR1000447	Bulastog (IRGC 44358)	Indica	Ilocos Norte	White	-----	-----	-----	-----
CLUSTER 22									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
19	PRR1000834	Bulibod na Puti	Indica	Quezon	-----	-----	-----	-----	-----
427	PRR1005276	Galiano (IRGC 44424)	Indica	Pangasinan	White	-----	-----	165.20	-----
388	PRR1003981	Denorado (97-MAG 5)	Javanica	Maguindanao	-----	-----	-----	174.98	-----
380	PRR1001793	Dinorado A	No Data	South Cotabato	Brown	-----	-----	115.42	-----
378	PRR1000805	Dinurado	No Data	Quezon	Brown	-----	-----	134.56	-----
376	PRR1000641	Dinorado (96-ARAK 3)	No Data	North Cotabato	-----	-----	-----	-----	-----
38	PRR1000255	Balasang (IRGC 44288)	Indica	Ilocos Norte	White	Spindle	2.5-2.99	181.54	-----
265	PRR1005270	Borik (IRGC 44351)	Indica	La Union	-----	Half-spindle	2.0-2.49	169.90	-----

CLUSTER 22

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
264	PRRI000874	C-1 (Pula/Puti)	No Data	Cavite	White	Half-spindle	2.0-2.49	138.62	21.2
47	PRRI000653	Binato (96-OCM 12)	Indica	Occ. Mindoro	White	Half-spindle	2.0-2.49	138.62	21.2
383	PRRI002786	Dinorado FG 653	No Data	Leyte	Brown				
147		Bengawan (IRGC 47096)	Indica	Ilocos Norte	Brown				
251	PRRI002716	Binatang	Indica	Quezon	Brown		106.00	106.00	127.82
270		Bangbang (IRGC 53131)	Indica	Benguet					
160	PRRI002294	Bina-ay (96-ABR 8)	Indica	Abra					
230	PRRI002958	Milagrosa (IRGC 5159)	Indica	Laguna					
241	PRRI003143	Camuros (IRGC 44376)	Indica	Occ. Mindoro					
166	PRRI003185	Kinandang Pula	Indica	Ilocos Sur					
237	PRRI003325	Kamoros (IRGC 52851)	Indica	Aklan	Red		185.8	185.8	
371	PRRI003526	Dinunan (IRGC 11222)	Javanica	N. Vizcaya	Light Brown	Half-spindle	2.0-2.49	128.66	11.2
219	PRRI003803	Milagrosa (97-CAT 3)	Indica	Catanduanes	Red				
202	PRRI005098	Americana (IRGC 54133)	Indica	Indonesia	White			191.2	14.2
272	PRRI002871	Binastian (IRGC 740)	Indica	No Data					

CLUSTER 23

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
17	PRRI002466	Balibud (IRGC 26871)	Indica	Isabela					
424	PRRI003284	Galliano (IRGC 47209)	Indica	Apayao	Red			181.06	
390	PRRI003518	Detagen (IRGC 11317)	Javanica	N. Vizcaya					
41	PRRI003129	Binalasang (IRGC 44321)	Indica	Ilocos Norte					
271			Indica	India					
45	PRRI001014	Binato (96-ABR 62)	Indica	Abra	White	Half-spindle	2.0-2.49	172.26	16.8
121	PRRI000201	Macan Caraboa	Indica	N. Ecija	White			147.8	
389	PRRI003513	De-Tagen (IRGC 11265)	Javanica	N. Vizcaya	White	Spindle	2.5-2.99	119.16	16.2
132	PRRI002759	Bukay/Basilanin Puti	No Data	Palawan	White			175.36	

CLUSTER 24

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
78		Binerhen	Indica	No Data					
357		Digha (Sada)	Indica	Bangladesh					

CLUSTER 25

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
74	PRRI002235	Azucena 2	Indica	Iloilo	White	Long-spindle	≥3.0	160.24	14.4
75	PRRI002438	Azucena (IRGC 52861)	Indica	Sorsogon					
76	PRRI002441	Azucena (IRGC 328)	Indica	Palawan				166.22	
85	PRRI002170	Binirhen B (Field C)	Indica	Batangas	Light Brown			124.64	
83	PRRI001783	Binirhen A (Field C)	Indica	Batangas	White			100	

Appendix Table 1. Continued

CLUSTER 26									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
84	PRR1001878	Binirhen (B)	Indica	Batangas	White			131.74 cm	
363	PRR1003148	Daliket (Pilis)	Indica	No Data					
108	PRR1001981	C 22	Indica	No Data					
104	PRR1003128	Binagimbing	Indica	No Data					
126	PRR1000443	Ballukok (IRGC 44300)	Indica	La Union	White				
127	PRR1000393	Balokok (IRGC 53129)	Indica	Benguet	White			163.14 cm	
106	PRR1002878	Bulao (IRGC 797)	Indica	No Data					
CLUSTER 27									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
140	PRR1003330	BIUD (IRGC 52871)	Indica	Agusan d. Sur					
384	PRR1002893	Denorado (IRGC 3827)	Indica	No Data					
385	PRR1002943	Dourado Agaulha	Indica	No Data					
CLUSTER 28									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
15	PRR1002462	Balibod (IRGC 38722)	Indica	N. Ecija	White	Half-spindle	2.0-2.49mm	151.88 cm	20.2
423	PRR1001775	Galliano	Indica	Cagayan Bangla-desh					
352		Digha (IRGC 26453)	Indica						
413	PRR1001843	Fancy	Hybrid	Ilocos Sur	White			145.62 cm	
52	PRR1002551	Binayabas	Indica	N. Ecija					
319	PRR1001576	C4-87-21-1	No Data	No Data					
134	PRR1002533	Bineg-it	No Data	Quirino					
150		Bengawan mutant	No Data	No Data					
159	PRR1001008	Bina-ay (96 -ABR 25)	Indica	Abra					
320	PRR1002388	C4-878-21-1	No Data	No Data					
206	PRR1005102	Anbarboo (IRGC)	Indica	Iran	White			161.80 cm	
215	PRR1004679	Milagrosa (2004)	No Data	Palawan					
216	PRR1003805	Milagrosa (98 -Qui 5)	Hybrid	Quirino					
234	PRR1002152	Sigadis Milagrosa	No Data	No Data					
263	PRR1002271	C-1	No Data	Batangas	White	Long-spindle	≥3.0 mm	101.44 cm	12.6
269	PRR1002479	Banban (IRGC 11193)	Indica	N. Vizcaya	White			132.80 cm	
CLUSTER 29									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
98	PRR1004387	Awot (LB ML 208)	Indica	Kalinga					
149		Bengawan mutant	No Data	No Data					

CLUSTER 30

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
53	PRR1002447	Bakhaw (97-CAT-26)	Indica	Catanduanes					
356		Digha(IRGC110364)	Hybrid	Bangladesh					
344	PRR1002172	DA Var D	No Data	No Data					
252	PRR1002951	Binatangan	Japonica	No Data					
250	PRR1000675	Kamoros(96-Ant 21)	No Data	Antique					
233	PRR1003804	Milagrosa(97-CAT6)	Indica	Catanduanes					
156	PRR1002731	Batang Anai	No Data	Indonesia	White	Long-spindle	>3.0	115.6	27.4
155	PRR1000779	Batang Anai	No Data	Indonesia					
148	PRR1003264	Bengawan (M)	No Data	No Data					
249	PRR1000677	Kamoros (96- CAP 4)	Indica	Capiz	Red			132.12	
54	PRR1000384	Bakhaw (IRGC 52863)	Indica	Sorsogon	Brown			154.34	
86	PRR1002168	Binirhen (Field B)	Indica	Batangas	White			104.84	

CLUSTER 31

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
358	PRR1000784	Digul (F1 7)	No Data	Indonesia					
362	PRR1001894	Diket (Pilis)	Hybrid	N. Ecija				135.60 cm	

CLUSTER 32

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
11	PRR1000804	Belibod na Pula	Indica	Quezon	Light Brown				
12	PRR1003332	Bolibod(IRGC52874)	Indica	Leyte					
62	PRR1001917	Basmati 370	Indica	India	White				
66	PRR1001866	Azucena	Indica	Batangas	White				
67	PRR1001867	Azucena	Indica	Batangas	White				
298	PRR1003138	Buayan(IRGC44354)	Indica	Zamboanga	White	Half-spindle	2.0-2.49mm		
310	PRR1002816	C-21 (IRGC 331)	Indica	Laguna					

CLUSTER 33

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
16	PRR1002464	Balibod (IRGC 44296)	Indica	Occ. Mindoro					
414	PRR1003549	Fancy (IRGC 79035)	Hybrid	Ilocos Sur					
350	PRR1002744	Diamante	No Data	Eastern Samar					
347	PRR1003006	Dinayang	Indica	Palawan					
311		C4-137	Hybrid	Laguna					
18	PRR1002465	Balibod (IRGC 52864)	Indica	Cam. Sur					
20	PRR1002877	Bolibod natural	Indica	Laguna					
23	PRR1000145	Balibod (IRGC 52865)	Indica	Cam. Sur	Red	Half-spindle	2.0-2.49mm		
24	PRR1002714	Balibod na pula	Indica	Quezon					

Appendix Table 1. Continued

CLUSTER 33									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
25	PRRI002714	Bilibod na pula	Indica	Quezon	Brown	Spindle	2.5-2.99 mm	130.54 cm	28.6
39	PRRI000570	Balasang (IRGC44289)	Indica	Ilocos Norte	White				
321	PRRI001149	California 1	No Data	US					
317	PRRI003395	C4-63 (IRGC 11352)	Indica	Laguna					
260	PRRI002259	C-1	No Data	Batangas					
144	PRRI000090	Bimmitit (IRGC 44316)	Indica	La Union	White			159.74 cm	
146	PRRI003264	Binakayo (IRGC 47096)	Indica	Pampanga					
151	PRRI002610	Binangahan	No Data	Eastern Samar					
313	PRRI001032	C4-63 (Purple Base)	Hybrid	Laguna					
152	PRRI001032	Binangahan	No Data	Eastern Samar					32.8
153	PRRI003399	BE (IRGC 44315)	Indica	Ilocos Norte					
157	PRRI002862	Binagacay (IRGC 604)	Javanica	No Data					
162	PRRI002296	Binaay (96-ABR 14)	Indica	Abra					
168	PRRI002256	Kinandang puti	Indica	Batangas	White			122.60 cm	
172	PRRI002777	Kinandang puti	No Data	Batangas	Brown			143.84 cm	
176	PRRI002715	Kinandang puti	Indica	Quezon	White			87.32 cm	
177	PRRI002937	Kinandang puti (IRGC)	Indica	No data					
322	PRRI003397	C4-63 (Green base)	Hybrid	Laguna					
199	PRRI000569	Ampipit (IRGC 44273)	Indica	Ilocos Norte					12.8
228	PRRI003801	Milagrosa (97-Cat 23)	Indica	Catanduanes	Red				
229	PRRI003808	Milagrosa (Pula)	Indica	Catanduanes					
224	PRRI004045	Milagrosa (97-Akl 2)	Indica	Aklan	White			151.56 cm	
222	PRRI003802	Milagrosa (97- Cat 28)	Indica	Catanduanes	Brown				
223	PRRI003806	Milagrosa (Fancy)	No Data	No data	White			139.16 cm	
227	PRRI003393	Milagrosa (IRGC 53182)	Indica	N. Vizcaya					
200	PRRI001753	Amelia	Indica	N. Vizcaya				148.30 cm	
312	PRRI003396	C4-137 (IRGC 11354)	Hybrid	Laguna					
201	PRRI000070	Amelia (IRGC 38717)	Indica	N. Ecija					
214	PRRI000975	Milagrosa	No Data	N. Ecija	White	Half-spindle	2.0-2.49 mm	164.00 cm	12.4
314	PRRI000975	C4-63 FG 080	Indica	No data					
CLUSTER 34									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
60	PRRI000949	Basmati 372	Indica	India	White				
323	PRRI001834	California	Indica	Cagayan	White				
309	PRRI000827	C-21	Indica	Laguna		Half-spindle	2.0-2.49mm		

CLUSTER 34									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
292	PRR1002983	BPI76	Indica	No data	-----	-----	-----	-----	-----
316	PRR1001535	C4-63 G	No Data	Laguna	-----	-----	-----	-----	-----
196	-----	-----	-----	-----	-----	-----	-----	-----	-----
194	PRR1002162	Ambul	Indica	Cagayan	White	-----	-----	85.72	-----
197	-----	-----	-----	-----	-----	-----	-----	-----	-----
138	PRR1002949	Dumali (IRGC 5105)	Indica	No data	-----	-----	-----	-----	-----
289	-----	-----	-----	Cagayan	-----	-----	-----	-----	-----
161	PRR1002408	Binaay bayag	Indica	Mt. Province	White	-----	-----	96.86	-----
259	PRR1002813	C-1 (IRGC 290)	Japonica	Laguna	-----	-----	-----	-----	-----
72	PRR1001916	Azucena	No Data	S. Cotabato	-----	-----	-----	-----	-----
96	PRR1001757	Awot	Indica	S. Cotabato	Red	Half-spindle	2.0-2.49	170.28	15.2
315	-----	C4-63 G	No Data	No data	-----	-----	-----	-----	-----
109	PRR1001982	C 22	Indica	No data	-----	-----	-----	-----	-----
CLUSTER 35									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
100	PRR1000060	Balatinaw	Indica	Mt. Province	White	-----	-----	168.50	-----
303	PRR1005408	Bungan	Indica	Iran	White	Long-spindle	>3.0	159.80	19
299	PRR1003139	Buayan Blanco	Indica	Zamboanga	-----	-----	-----	-----	-----
297	PRR1003752	Brown Gora	Indica	India	Brown	-----	-----	131.36	-----
304	PRR1005410	Bungan (IRGC 32287)	No Data	Iran	-----	-----	-----	-----	18
278	PRR1001853	Beniding	Hybrid	Cagayan	White	-----	-----	109.18	-----
325	PRR1000883	Calrose 3 (M-202)	No Data	US	Light Brown	-----	-----	136.04	-----
339	-----	Chinsurah Boro 2	O. glabberima	India	-----	-----	-----	-----	-----
277	PRR1002165	Binibi	Binibi	Palawan	-----	-----	-----	-----	-----
324	PRR1004493	California rice	No Data	No data	-----	-----	-----	-----	-----
302	PRR1005409	Buncan (IRGC 32285)	Indica	Iran	White	Spindle	2.5-2.99	146.70	19.2
300	PRR1000264	Bolastog(IRGC 44345)	Indica	Ilocos Norte	-----	-----	-----	-----	-----
341	-----	Chinsurah Boro 2	Indica	Indonesia	-----	-----	-----	-----	-----
170	PRR1001910	Kinandafor	Indica	N. Ecija	-----	Spindle	2.5-2.99	113.12	16.2
CLUSTER 36									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
68	PRR1000698	Azucena	No Data	N. Ecija	-----	-----	-----	-----	-----
267	PRR1001802	Bandera	Indica	N. Ecija	-----	Half-spindle	2.0-2.49	117.56	19.8
CLUSTER 37									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
154	PRR1000788	BE 3	Indica	Iloilo	White	-----	-----	-----	-----

Appendix Table 1. Continued

CLUSTER 37									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
346	PRR1003005	Dayang-Dayang(19398)	Indica	Palawan	White	Spindle-shape	2.5-2.99	98.26	19.4
345	PRR1003004	Dayang-dayang (19397)	Indica	Palawan	White	Spindle-shape	2.5-2.99	98.26	19.4
220	PRR1003220	Milagrosa(IRGC 44634)	Indica	No data	White	Spindle-shape	2.5-2.99	98.26	19.4
CLUSTER 38									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
331	PRR1002802	Cambodia 1 (FC 12)	No Data	Cambodia	White	Long spindle	≥3.0	142.7	133.16
420	-----	Gabura (IRGC 37428)	Indica	Bangladesh	White	Long spindle	≥3.0	142.7	133.16
337	PRR1005113	China Patarka	No Data	Fiji	White	Long spindle	≥3.0	142.7	133.16
CLUSTER 39									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
353	-----	Digha (IRGC 26454)	Indica	Bangladesh	White	Long spindle	≥3.0	142.7	133.16
355	-----	Digha (IRGC 31770)	Indica	Bangladesh	White	Long spindle	≥3.0	142.7	133.16
CLUSTER 40									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
279	PRR1004405	Beniding (96- CAG 03)	No Data	Cagayan	White	Long spindle	≥3.0	111.3	111.3
293	-----	BPI RI 10 1991 DS-039	Hybrid	No data	White	Long spindle	≥3.0	111.3	111.3
CLUSTER 41									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
131	PRR1003410	Basilanin (98- PAL 101)	Indica	Palawan	White	Long spindle	≥3.0	96.88	96.88
326	PRR1000884	Calrose 2 (L-203)	No Data	US	White	Long spindle	≥3.0	96.88	96.88
CLUSTER 42									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
27	PRR1001919	Batangena	No Data	Palawan	White	Long spindle	≥3.0	96.88	96.88
295	-----	BPI RI 10	No Data	N. Ecija	White	Long spindle	≥3.0	96.88	96.88
286	PRR1002977	Binundok(IRGC5991)	India	No data	White	Long spindle	≥3.0	96.88	96.88
CLUSTER 43									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
285	PRR1000010	Binondoc (IRGC 38726)	Indica	N. Ecija	White	Long spindle	≥3.0	96.88	96.88
305	-----	Burdagol TML 5	No Data	N. Ecija	White	Long spindle	≥3.0	96.88	96.88
306	-----	Burdagol	No Data	N. Ecija	White	Long spindle	≥3.0	96.88	96.88
CLUSTER 44									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
28	PRR1003426	Batangena	No Data	Palawan	White	Long spindle	≥3.0	96.88	96.88
30	PRR1003426	Batangenio	No Data	Palawan	White	Long spindle	≥3.0	96.88	96.88
240	PRR1003144	Camuros na puti	Indica	Or. Mindoro	White	Long spindle	≥3.0	96.88	96.88

CLUSTER 45									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
33	PRRI000184	Balasang (IRGC 5167)	Indica	Nueva Ecija	White	-----	-----	-----	-----
35	PRRI003370	Binalasang(IRGC52971)	Indica	Ilocos Sur	-----	-----	-----	-----	-----
CLUSTER 46									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
31	PRRI003482	Bursinay(2003-11-0107)	No Data	Occ. Mindoro	-----	-----	-----	-----	-----
34	PRRI003369	Binagsang (IRGC 52970)	Indica	Ilocos Sur	Red	-----	-----	207.80 cm	-----
36	PRRI004401	Bumalasang	Javanica	Nueva Ecija	White	-----	-----	122.90 cm	-----
CLUSTER 47									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
360	PRRI001158	Dalikit (Buluhan)	No Data	Cavite	White	-----	-----	141.50 cm	-----
366	PRRI003573	Habolde Dayakot	Indica	Ifugao	White	-----	-----	143.20 cm	-----
361	PRRI001823	Dalikit	Indica	Cavite	-----	-----	-----	-----	-----
CLUSTER 48									
No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
332	-----	CG-14 TML 41	O. glabberima	Laos	-----	-----	-----	-----	-----
333	-----	CG-14	O. glabberima	Senegal	-----	-----	-----	-----	-----

Appendix Table 2. List of the 31 unique Philippine rice accessions that clustered individually, including passport data and key morphological traits.

No.	ACC. Code	Variety	Sub-Species	Origin	Seed Coat Color	Seed Shape	Seed Length (mm)	PLT Height (cm)	Ave. No. of Panicle/Plant
4	PRR1000442	Binangkuro (IRGC 44292)	Indica	Ilocos Norte	White	---	---	---	---
26	PRR1001919	Batangas mixture minantika	No Data	Batangas	---	---	---	---	---
29	PRR1002171	Batangas mixture (Ginitan)	Indica	Batangas	---	---	---	---	---
51	PRR1002997	Bayabas (IRGC 19385)	Indica	Palawan	---	---	---	---	---
55	PRR1000965	Basmati narot 493	Indica	India	Speckled brown	---	---	144.3	---
57	PRR1004402	Bashmoti (D)	Indica	No data	---	---	---	---	---
64	PRR1000969	Basmati 5851	Indica	India	---	Long-spindle	≥3.0	155.6	15.2
69	PRR1002234	Azucena 1	Javanica	Iloilo	---	---	---	---	---
77	PRR1003126	Benerhin (IRGC 44311)	Indica	Occ. Mindoro	---	---	---	---	---
111	PRR1001968	C 22	Indica	No data	White	Spindle	2.5-2.99	145.94	28.8
115	-----	C 22	Indica	No data	---	---	---	---	---
116	-----	C 22	Indica	No data	---	---	---	---	---
117	-----	No data	Indica	No data	---	---	---	---	---
135	PRR1002190	Binig-it	No Data	No data	---	---	---	---	---
181	PRR1002269	Kinanda	No Data	Batangas	---	---	---	---	---
182	PRR1002765	Kinandang puti	Indica	Batangas	Brown	---	---	141.26	---
212	PRR1000729	Sigadis Milagrosa	No Data	N. Ecija	Brown	---	---	90.28	---
266	PRR1001847	Burik	Indica	Cagayan	White	Half-spindle	2.0-2.49	179.8	14.4
276	PRR1000923	Binibe (96-OCM 49)	Indica	Occ. Mindoro	Red	Semi-round	1.5-1.99	146.6	13.4
284	PRR1005322	Binuhangin (IRGC 67430)	Indica	Cavite	White	Spindle	2.5-2.99	101.02	27.8
294	-----	BPI RI 10 TML 40	No Data	Nueva Ecija	---	---	---	---	---
296	-----	Brown Gora TML 40	Indica	India	---	---	---	---	---
307	PRR1002268	Bureau	No Data	Batangas	White	---	---	137.6	---
308	PRR1002763	Bureau (aromatic)	No Data	Batangas	White	---	---	147.92	---
330	PRR1000778	Cambodia 3 (FC 14)	No Data	Cambodia	---	---	---	115.66	---
336	PRR1002609	China rice	No Data	Eastern Sa-mar	---	---	---	---	---
340	-----	ChinsurahBoro2 (IRGC 11760)	Indica	India	---	---	---	---	---
351	PRR1004512	Diamante (IRGC 44393)	Indica	No data	---	---	---	---	---
364	PRR1003520	Diket (98- Qui 16)	Javanica	Quirino	---	---	---	---	---
365	PRR1003521	Diket (98- Qui 20)	Javanica	Quirino	---	---	---	---	---
412	PRR1002213	Eurian	No Data	N. Ecija	---	---	---	---	---