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Diversity analysis and genetic potency identification of local rice cultivars in Penajam Paser Utara and Paser Districts, East Kalimantan

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Abstract. *Nurhasanah, Sadaruddin, Sunaryo W. 2016. Diversity analysis and genetic potency identification of local rice cultivars in Penajam Paser Utara and Paser Districts, East Kalimantan. Biodiversitas 17: 401-408.* Local rice cultivars provide genetic diversity in rice genepool that is very useful for rice breeding programs. Less is known about local rice genetic diversity in East Kalimantan, because their existence only depends on traditional cultivation and conservation by local farmers based on needs and tendencies towards certain varieties. According to the current exploration study conducted in Penajam Paser Utara (PPU) and Paser, the smallest districts in East Kalimantan, there were high genetic diversities of rice existed in that two districts. As many as 71 local rice cultivars were collected, consisted of 53 rice and 18 glutinous rice. Traits characterization showed that there were large variation of plant height (66 to 209.33 cm), culm number (1 to 41.67), culm diameter (0.23 to 1.03 cm), leaf length (39 to 108.33 cm), leaf width (0.83 to 2.67 cm), leaf angle (10 to 50 degree), ligule length (11 to 55 mm) and weight of ten seeds (0.13 to 0.40 gram) in the local rice population showing high phenotypic variations of agro-morphological traits in the population. A strong negative correlation between culm number (tiller) and culm diameter, leaf length as well as leaf width was observed, which indicated that culm number is few if the culm diameter is big, and the leaves are longer and wider. Genetic diversity analysis based on Agro-morphological characters clustered the cultivars in nine and four classes for rice populations in PPU and Paser districts, respectively. Pre-identification of the local rice genetic potencies showed some superior and potential traits which will be very useful for rice breeding programs to develop new superior rice varieties.

Keywords: Diversity, East Kalimantan, genetic potency, local rice, traits characterization

INTRODUCTION

Rice is a staple food for most of Asian country. It is widely cultivated all over the world, not only in Asia, but also in America, Europe, Australia and Africa (Longtau 2000; FAO 2016). Even though it is wide world cultivated, but more than 90% of this rice is consumed in Asia (IRRI 2016). Population growth is one of the main factors leads to the increase demand for rice. To fulfil the need for the food, various efforts have been done to enhance rice productivity, including the use of superior rice variety.

Nowadays, plant breeder is not only focused on the development of new superior variety having high yield and quality, but also tolerance and adaptable to environmental stress factors towards resilient and sustainable agricultural system (Brummer et al. 2011; Meybeck et al. 2012). The existence of rice genetic diversity is very important in supporting this purpose, since the genetic diversity is the raw material for the assembly of new superior varieties.

As a center of biodiversity spot in Indonesia, East Kalimantan is a home of various plant species, including rice. Hundred local rice varieties were reportedly existed in East Kalimantan, included lowland and upland rice varieties. Local rice cultivars have high genetic variability due to their adaptation to a wide range of agro-ecological conditions (Yawen et al. 2003; Sarawgi and Bine 2007). They may provide genetic diversity to diversify rice genepool that is very useful for new superior rice varieties development. Unfortunately, most of local species diversity is not well recorded and characterized. Therefore less information is also available about their characteristic.

Traits characterization has been one of the important step of crop improvement. Each species possess a specific functional trait, such as genetic, phenological, dispersal, physiological, etc (Lebrija-Trejos et al. 2010). Almost all morphological traits were associated with macro habitats. Morphological traits are directly related to the interaction between a species and its environment (Westoby and Wright 2006). Morphology includes some of the most accessible and functionally important traits, with the potential to be measured for each species (Fukuoka et al. 2006).

Assessment of genetic diversity is important in plant breeding. Genetic diversity is commonly measured by genetic distance or genetic similarity implying either differences or similarity at the genetic level showing relationship among genotypes in germplasm is very useful for plant breeding programs. It will support the selection decision from large genotypes population for crossing combinations in plant development. Genotype relationship is mainly based on information about plant characteristic. Agronomic and morphological characters are usually used as an initial tool to distinguish between varieties (Li et al. 2010).

The aim of the present study was to collect local rice germplasm in PPU and Paser Districts for genetic diversity analysis, and to characterize their agro-morphological characters, identify their genetic potency and analyze the genetic distance among cultivars.

MATERIALS AND METHODS

Exploration study

Exploration study was carried out in Penajam Paser Utara (PPU) and Paser Districts in East Kalimantan Province. In Paser District, the exploration was conducted in Kayongo Sari, Muara Pias, Munggu, Olung, Papara, Putang, Riwang, Sekuan Makmur and Sungai Tuak Villages. The exploration sites in PPU District were in Api-api, Babulu Laut, Labangka, Riko, Rintik and Sumber Sari Villages (Figure 1).

The exploration was conducted in 2014 at two different times, along rice growing period and at or after harvest time. Rice genetic diversities were collected directly from local farmers. Information about rice varieties and the genetic potencies (interesting traits based on local community observation) were collected from informal interviews and dialogues through direct participatory technique using both directed and open-ending questioning with community members and the farmer.

Field experiment

The rice cultivars collected from exploration study were grown in green house for phenotypic traits observation. The seeds were grown in plastic pots containing 10 kg of soil based on their cultivation types, upland or lowland. The pots were arranged in completely randomized designs with three replications, each pot was considered as one replication. The upland rice cultivars were grown in perforated pot, while the lowland were in the unperforated. Prior to planting, the lowland rice seeds were germinated, after the seedlings were 21 days old, they were transferred to the growing pots. For the upland rice cultivars, the seeds were directly sown in the soil. Each pot contained only one plant. The plants were treated according to general rice cultivation procedure.

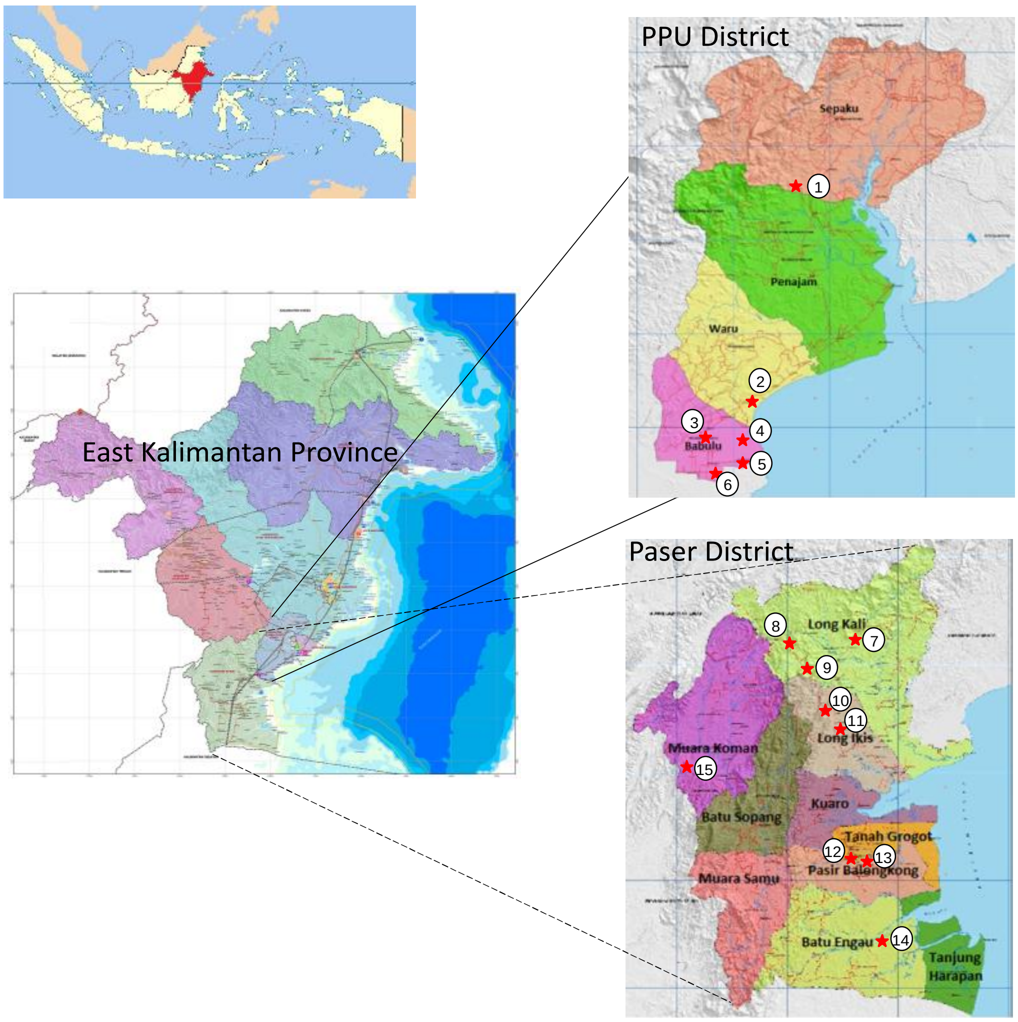

Figure 1. Rice diversity exploration sites in Penajam Paser Utara (PPU) and Paser Districts in East Kalimantan. Stars (*) indicating the exploration sites: 1. Riko, 2. Api-api, 3. Labangka, 4. Babulu Laut, 5. Sumber Sari, 6. Rintik (PPU District); 7. Munggu, 8. Muara Pias, 9. Putang, 10. Olung, 11. Kayongo Sari, 12. Sungai Tuak, 13. Papara, 14. Riwang, 15. Sekuan Makmur (Paser District).

Agro-morphological trait observation and data analysis

Several Agro-morphological traits, i.e: plant height, culm (number, diameter, angle, internode color), leaf (length, width, angle, blade pubescence, basal leaf sheath color, blade color), ligule (length, color, shape, auricle color), auricle color and grain (length, width, weight of 10 seeds, lemma and palea color, awning, apiculus color) were observed to characterize the cultivars phenotypically. The traits were characterized based on descriptors for rice procedure by IRRI (1980). The data were used to classify rice cultivars into different groups based on their similarity degree using cluster analysis. The cluster analysis was carried out using Euclidian Distance, the distances between clusters were determined using single linkage analysis, which were performed using SPSS Statistic version 20. The cluster analysis result was presented on dendrogram. Correlations between quantitative traits were carried out using Pearson correlation to analyze the relationship between the traits.

RESULTS AND DISCUSSION

Local rice biodiversity

There was a relatively high rice diversity observed in PPU and Paser Districts. The rice biodiversity is unequally dispersed in nine villages in Paser and six villages in PPU District (Table 1). Riwang and Kayongo Sari are the spots of local rice diversity in Paser, as Riko and Sumber Sari in PPU. Thirty and fourty one rice cultivars were collected in PPU and Paser Districts, respectively. The higher rice diversity found in Paser District than in PPU was not only due to the more villages were visited, but also the wider area. PPU is the smallest district in East Kalimantan, followed by Paser. The large of the regions are only 2.52% (PPU) and 8.79% (Paser) of East Kalimantan Province. The land use for agriculture is also higher in Paser than in PPU, that is 429.950 Ha and 93.125 Ha for the two regions, respectively (BPS-Statistics of East Kalimantan Province (2015).

Most of the rice are non-glutinous rice, and only about 25% of them are glutinous rice. Based on the cultivation method commonly applied by the local farmer, majority of the rice was cultivated as upland rice (Table 2), especially in Paser District. The higher upland rice diversity might be caused by plant domestication process and adaptation to the local cultivation procedure that has been applied by local community. Generally the local people practices the traditional, low effort and low technology of cultivation. Therefore, the upland rice are preffered rather than low land rice, which is lead to the increase of upland rice diversity. On the other hand a slightly higher number of low land than upland rice diversity was observed in PPU. PPU is placed near to Balikpapan and Samarinda City, and most of the areas are easily to attain. It is also a gate of Paser, it means that we have to enter PPU first before entering Paser. Therefore cultivation information and technology is easy to touch the local community. As a result, the local farmer has adapted several upland rice cultivars, such as Mayas, Sereh, Sasak Jalan, as well as glutinous rice cultivars which are normally cultivated as upland rice in other Districts, to be cultivated in low land method for higher yield purpose.

We observed several grain color variation in the local rice population. There are brown and black, beside white grain colour. The black grain is a glutinous rice, the brown is unglutinous rice, and the white grain color consist of unglutinous and glutinous rice. The black and brown grain rice can be used as functional food, which is not only as carbohydrate source but also contains active substance beneficial for health and special diets. Black and brown rice contains vitamin B complex, essential fatty acids, fiber and anthocyanins as well as a low glycemic index which are beneficial to health (Zhang et al. 2010). Brown rice is also a source of selenium, a mineral that can boost the natural killer cells of cancer cells, mobilizes the cells to fight the cancer cells and may act as an antioxidant (Smith and Charter 2010). Diet foods made from rice, could be expected to lower the risk of obesity, hepatic steatosis, hyper glycemic, diabetic (Jang et al. 2012), and prevent headaches, colon cancer, heart disease, Alzheimer's disease and reduce hypertension (Sutharut and Sudarat 2012).

Trait characterization

Traits variation were observed in agronomical and morphological characters of the local rice. A large range of plant height, culm number, culm diameter, leaf length, leaf width, leaf angle, ligule length and weight of ten seeds in local rice population originated from PPU (Figure 2) and Paser (Figure 3) showed a high genetic diversity. A range of 126.67 to 203.33 cm of plant height was noticed for the rice population in PPU, in which most of the cultivar‘s plant height is higher than 1.5 m (Table 3). Interestingly, about 55 % of the population was lowland rice cultivars, and none of them have plant height lower than 1 m, as a normal plant height of lowland rice variety. In addition, Menyan cultivar which has the highest plant height of 203.33 cm is also grown as lowland rice.

Table 1. Rice exploration result in PPU and Paser Districts in East Kalimantan

Districts	Villages	Number of rice cultivars
PPU	Api-api	1
	Babulu Laut	4
	Labangka	1
	Riko	9
	Rintik	5
	Sumber Sari	10
Paser	Kayongo Sari	8
	Muara Pias	5
	Munggu	3
	Olung	1
	Papara	2
	Putang	2
	Riwang	9
	Sekuan Makmur	7
	Sungai Tuak	4
Total		71

Large genotypic variation of plant height was observed in Paser rice population, range from 66 to 209.33 cm (Table 3). The lowest plant height of 60 cm is Siang Inul cultivar, and the highest is Sereh Kuning, which were grown in upland condition. Althought plant height is affected by many factors, such as plantation method, plant density and fertilizer application (Aide and Beighly 2006), but in this case all the environmental factors are similarly applied. Therefore, the character differences showed the genetic potency of the genotypes.

Plant height in rice is generally considered to be controlled by both qualitative and quantitative genes (Huang et al. 1996). The presence of dwarf plant like Siang Inul, and tall plant as Sereh Kuning cultivar can be used to further identify the genes controlling plant height in rice, and for assembling superior dwarf upland rice variety. Plant height has positive correlation to lodging, the displacement of culms from an upright position, which is often associated with yield loss (Navabi et al. 2006; Hui-Jie et al. 2000). The higher of plant hight leads to high risk of lodging. Therefore plant height reduction is a specific interesting in breeding programs to overcome the lodging problem. Although taller plants tend to be more susceptible to lodging, in this study several tall genotypes showed tolerance to lodging (data was not shown) indicating their genetic tolerance.

Variation was also observed for other agronomical characters as presented in Table 3, especially for the traits having significant correllation with plant height. Culm diameter, leaf length and leaf width have strong correlations with plant height (Table 4). Therefore, the traits widely varied following the large variation of plant height. Previous study conducted by Lasalita-Zapico et al. (2010) also observed a very significant positive correlations between plant height and culm diameter, leaf length and leaf width, supporting the current result. Significant positive correlations of the traits showed that, the higher of plant height, the bigger culm diameter, and the longer as well as the wider the leaves. In this study, it was observed that the tall plants also have big culms, length and wide leaves, and the shorter plants have small culms, short and narrow leaves.

There were strong negative correlations between culm number (tiller) and culm diameter, leaf length as well as leaf width (Table 4). It means that culms number are few if the culms diameter are big, the leaves are longer and wider. It was assumed that the plants that have fantastic vegetative growth, tall and big culm, long and wide leaf, have low ability to produce more tillers, eventhought variation was also observed in the population. The same indication was also observed by Wu et al. (2011), who stated that the large culm cultivars exhibited greater plant size, culm diameter, and flag leaf length and width, as well as lower tiller numbers, meaning that the large culm cultivars had markedly fewer tillers compared with the common culm width.

Tillering is one of the most important agronomic characters for grain production in rice (Smith and Dilday 2003). Tiller number per plant determines the panicle number, a key component of grain yield. High culm number is also one of the criteria for new superior rice variety. In the present study, most of the genotypes had culm number less than 15 in PPU (including into intermediate) and less than 10 (including into low) in Paser population. However, there were several local rice cultivars had high culm number. The highest culm number was produced by Ketan Pasero (41.67 culms), followed by Siam (33.33 culms), Ketan Botol (30.33 culms), Siam Mas (30 culms), Muncul (29 culms), Sereh2 (26.33 culms) in PPU's rice population, and Pance Puteh (35 culms), Pance Kuning (26.67 culms) in Paser's rice population. These genotypes can be used as parental candidate for the assembling of new superior upland rice variety. Although further investigation should be done for productive tiller and its relationship with high yield production.

Genetic variation for weight of 10 seeds was markedly large, varied from 0.16 to 0.38 and from 0.13 to 0.40 (Table 3) for PPU and Paser rice population, respectively. Nevertheless, most of the cultivars have weight of 10 seeds of more than 0.20 gram. Heavy seeds weight cultivars, having grain weight of more than 0.35 gram for ten seeds, was observed in Sasak jalan1 (0.38 gram) in PPU, and Sasak Jalan2 (0.36 gram) in Paser rice population. Most of the heavy seeds weight cultivars were dominated by glutinous rice variety, as Ketan Pasero (0.35 gram) in PPU, and Ketan Petion (0.36 gram), Ketan Kuatok (0.37 gram), Ketan Buyung Silong (0.38 gram), Ketan Belanda Krimpang (0.39 gram) and Ketan Tangkai Ngeno2 (0.40 gram) in Paser. One of phenotypic modifications of cereals from their wild progenitors is increaseing of seed sizes (Hancock 2004). This change, recognized as the domestication syndrome, is included into a basic requirement for effective seed harvest and planting and higher grain yield that made cultivation worthwhile.

Rice grain weight is considered to be a stable varietal character (Rabiei et al. 2004), with less than 5% coeffecient of variation (Cassman 1993). It means that genetic mainly influences its variation. Seeds weight is affected by seeds shape, i.e: long, width and thickness. According to Vanaja and Babu (2006), grain length and width atributes to rice yield. In this study, most of the cultivars included into very long grain and medium width (Table 5), and none of the genotype has short grain. Rice grain characteristics such as length, width, and shape have a direct effect on the marketability, and influence the commercial success of modern rice cultivars. Specific consumen prefer specific shape of rice grain, such as long and slim grain or short and big grain, which is also depends on the purpose. Therefore the availability of large genetic variation of rice grain is very important to provide all of the preference for the consumen.

Genetic diversity analysis

Cluster analysis was performed to find out the relationship among the cultivars. Based on several agro-morphological characters, the genetic relatedness among the cultivars could be figured out (Figure 4 and 5). The cultivars were grouped into nine and four classes for local rice population collected from PPU and Paser, respectively (Table 6). Most of the cultivars were grouped into the first

Table 2. Local rice genetic diversity in PPU and Paser Districts in East Kalimantan

Districts		PPU	Paser
Number of cultivars		**30**	**41**
Rice type	Rice	22	31
	Glutinous rice	8	10
Cultivation type	Lowland	16	5
	Upland	14	36
Grain color	Brown	2	0
	White	27	41
	Black	1	0

Table 3. Minimum (Min), maximum (Max) and mean value of quantitative traits of rice cultivars in PPU and Paser Districts, East Kalimantan

Characters	Min.	Max.	Mean	SD
PPU District				
Plant height (cm)	126.67	203.33	161.97	21.31
Culm number (culm)	4.33	41.67	13.80	10.48
Culm diameter (cm)	0.23	1.03	0.75	0.19
Leaf length (cm)	48.33	105.00	84.44	13.91
Leaf width (cm)	0.83	2.13	1.91	0.29
Leaf angle (degree)	10.00	50.00	26.67	12.25
Ligule length (mm)	13.00	55.00	22.29	7.98
Weight of 10 seeds (g)	0.16	0.38	0.28	0.05
Paser District				
Plant height (cm)	66.00	209.33	156.36	26.45
Culm number (culm)	1.00	35.00	7.85	8.45
Culm diameter (cm)	0.37	1.03	0.73	0.17
Leaf length (cm)	39.00	108.33	90.25	16.57
Leaf width (cm)	1.10	2.67	1.80	0.32
Leaf angle (degree)	16.67	50.00	34.04	9.41
Ligule length (mm)	11.00	26.00	19.85	5.09
Weight of 10 seeds (g)	0.13	0.40	0.23	0.4

Note: SD = Standart Deviation

Table 4. Correlations among several quantitative traits

Characters	Plant height	Culm number	Culm diameter	Leaf length	Leaf width	Leaf angle	Ligule length
Culm number	-0.28						
Culm diameter	0.60**	-0.50**					
Leaf length	0.62**	-0.61**	0.54**				
Leaf width	0.54**	-0.41**	0.73**	0.39**			
Leaf angle	0.38*	-0.38*	0.14	0.56**	0.06		
Ligule length	0.12	-0.23	0.15	0.29	0.06	0.11	
Weight of 10 seeds	0.20	-0.27	0.31*	0.20	0.35*	-0.09	-0.07

Note: *, **Significant at p=0.05 and p=0.01, respectively.

Table 5. Grain characteristics of local rice in PPU and Paser Districts, East Kalimantan

Character	Type	Number of genotypes	
		PPU	Paser
Grain length	Very long	26	38
	Long	4	3
Grain width	Big	6	2
	Medium	24	39

Table 6. Clustered class of PPU and Paser District local rice populations

Class	Genotype
PPU District	
I	Cilamaya, Dupa, Kemang Sungkai, Ketan Gunung, Ketan Hitam, Ketan Pasir, Ketan Tangkai Panjang, Lungku Dupa, Mayas, Mayas Merah, Muncul, Menyan, Putih (Siam), Sungkai, Sasak jalan1, Sasak jalan2, Sasak Jalan3, Sereh1, Sereh2, Tangkai mayang, Tihung
II	Siam Mas
III	Ketan Nunuk
IV	Ketan Botol
V	Ketan Pasero
VI	Siam
VII	Jambu
VIII	Jambu Jambu
IX	Ketan Merah
Paser District	
I	Geragai 1, Geragai 2, Ketan Kuning, Ketan Serang, Ketan Tagkai Ngeno, Lekatan Pelam, Lupa Pantai, Mayas Kuning, Mayas Putih, Benalu, Loreng, Pance Kuning, Pance Puteh, Raden Darat, Sasak Jalan1, Sasak Jalan2, Sereh Gunung, Sereh Kuning, Sereh Putih, Sebuyung Biasa, Sebuyung Harum, Siam Gunung, Tempu Maya
II	Prari
III	Siang Inul
IV	Rendah Kuning

Table 7. Genetic potency of the local rice varieties

Superior character*	Genotypes	Origin
Many tillers	Sereh Putih, Sereh Gunung, Pance Putih	Paser
Aromatic	Lupa Pantai, Jambu-jambu	Paser
	Ketan Botol, Ketan Pasir, Padi Menyan	PPU
Long panicle	Ace Cina, Sereh Kuning	Paser
Good taste	Ketan Kuning, Siam Gunung, Mayas Kuning, Pance Puteh, Elvi, Lekatan Pelam, Ketan Mayas, Tempu Maya, Padi Loreng, Mayas	Paser
	Jambu, Lungku Dupa, Padi Putih (Siam), Sasak Jalan, Ketan Gunung, Pare Kiongo, Ketan Hitam, Ketan Merah, Mayas Merah, Sungkai	PPU
Drier and firmer	Sasak Jalan	Paser
	Cilamaya, Cilamaya, Sasak Jalan, Sereh, Siam	PPU
Drier, firmer and aromatic	Pance Kuning	Paser
Uniform harvest time	Rendilo	Paser
Fluffy taste	Mayas Putih, Sebuyung Biasa, Raden Darat, Rendah Kuning	Paser
	Ketan Tangkai Panjang, Muncul, Sereh, Siam Mas, Tangkai Mayang, Tihung	PPU
Fluffy and aromatic	Sebuyung Harum, Padi Benalu	Paser
	Dupa, Kemang, Sungkai	PPU
Dwarf	Ketan Jenggot / Pulut Jangko'	Paser

Note: * The superior characters were based on the reason of cultivation by the local community

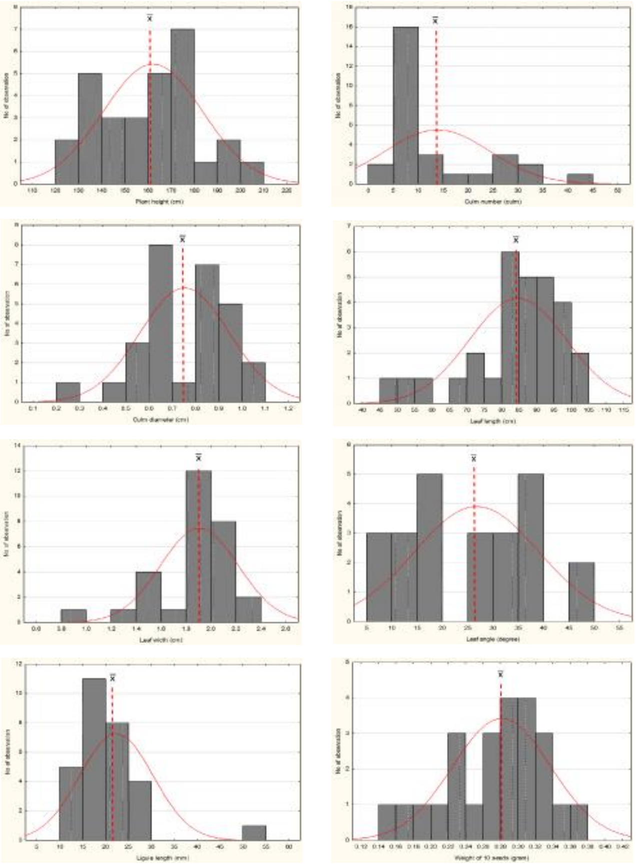

Figure 2. Quantitative traits distribution of local rice varieties in PPU District, East Kalimantan

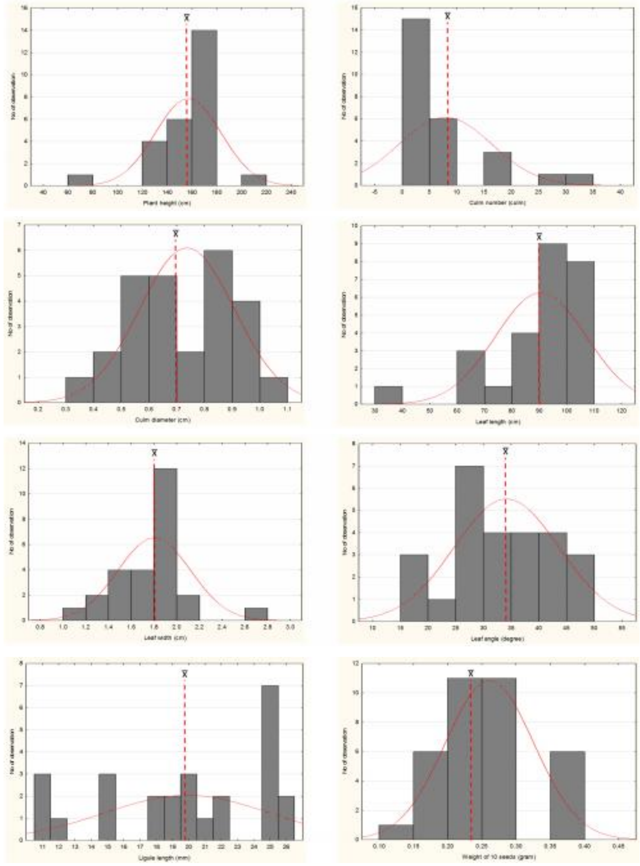

Figure 3. Quantitative traits distribution of local rice varieties in Paser District, East Kalimantan

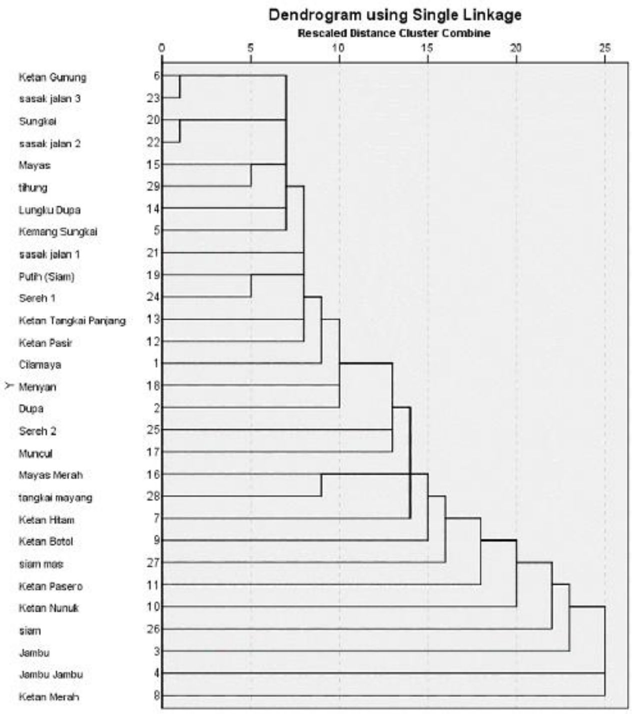

Figure 4. Cluster analysis of rice cultivars in PPU District, East Kalimantan

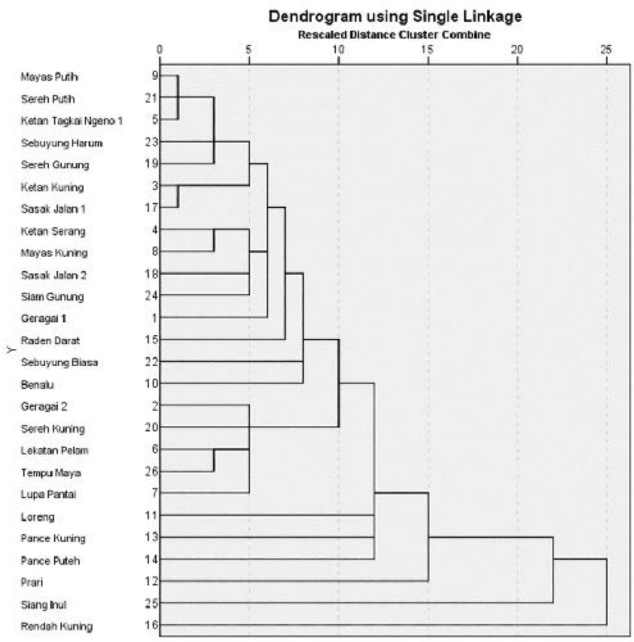

Figure 5. Cluster analysis of rice cultivars in Paser District, East Kalimantan

class for both of populations. Ketan Merah and Jambu-Jambu cultivars from PPU and Rendah Kuning from Paser District were the most distinct variety since they stood out as the most far apart cluster from the others (Figure 4 and 5).

The divergence for genetic diversity analysis was contributed by plant height, culm (number, diameter, angle, internode color), leaf (length, width, angle, blade pubescence, basal leaf sheath color, blade color), ligule (length, color), and grain (length, width, weight of 10 seeds, lemma and palea color, awning, apiculus color). Several morphological characters, i.e: auricle color (whitish), leaf color (green), leaf blade pubescence (intermediate), basal leaf sheath color (green), ligule shape (truncate), ligule color (whitish), had no variance among all cultivars.

Variance was observed in the same cultivars but collected from different location as in Sasak Jalan1, Sasak Jalan2, dan Sasak Jalan3 (having 68% similarity, with different ligule length, culm diameter and culm number); Sereh1 and Sereh2 (having 48% similarity, having different leaf angle, leaf length, culm diameter and culm number) which were collected from PPU District (Figure 4). Geragai1 and Geragai2 (60% similarity, with differerent culm angle, leaf angle, auricle length, seed length and awning color), Sasak Jalan1 and Sasak Jalan2 (having 76% simmilarity, with differerent culm number and auricle length) from Paser District were also grouped in the same class. Even thought there were variances, but they might genetically similar.

Genotypes having similar local name, such as Jambu and Jambu-Jambu, Siam and Siam Mas were clustered in different classes (Figure 4 and Table 6). In the study with aromatic rice landraces, Fukuoka et al. (2006) concluded that significant variation may be found among genotypes with the same name. According to Li et al. (2002) diversity analysis based on phenotypic values may not be the perfect representation of the natural groupings of cultivars, because the phenotypic characters are influenced by environmental. Therefore, further investigation using DNA based analysis should be conducted, to conclude whether the cultivars are genetically the same or not.

Genetic potency

Sustainability of local rice genetic diversity mostly depend on local community, because its cultivation and conservation mainly proceeded by the local farmer. Therefore, the availability of rice seed rely on the planting season and the tendency of the local community towards the certain genotypes. Generally, the farmer has a particular interest for certain variety. That specific interest is the reason for the farmers to grow the variety continuously and unconsciously preserve it.

Based on information collected from informal interviews with the local community, several genetic potencies of the local rice were recorded. The interesting trait of the variety is presented in Table 7. According to the local community observation, certain local rice cultivars carry specific superior characters showing their genetic potency. The superior characters were also the reason why the cultivars are cultivated by the local communities.

Most of the superior traits observed by the farmers are characters related to the taste quality, i.e: aromatic, good taste, fluffy, dried and firmer. Rice quality traits relate to the texture of the grain. Texture of the cooked rice is an important attribute of food acceptance by consumers. Waxy and non-waxy rice are usually classified according to their grain dimensions, amylose content, amylograph consistency, gelatinization properties of the extracted starches (Gonzales et al. 2004), which further determine the texture is fluffy or dried and firmer.

Good taste quality is a well known characteristic of East Kalimantan local rice (WWF 2013). It is also a reason for its high price, which is about 1.5-2 folds than that of the national rice variety in regional market. The price is even higher in international market of the neighborhood countries. In addition, the local rice cultivars also suggested to have tolerance to biotic and abiotic stress and carry other important alleles which have not been examined yet.

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