

## Ethnobotanical survey of bananas (Musaceae) in six districts of East Java, Indonesia

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**Abstract.** Hapsari L, Kennedy J, Lestari DA, Masrum A, Lestari W. 2017. Ethnobotanical survey of bananas (Musaceae) in six districts of East Java, Indonesia. *Biodiversitas* 18: 160-174. Ethnobotanical survey of bananas was conducted in six districts of East Java, Indonesia i.e. Pasuruan, Probolinggo, Banyuwangi, Lumajang, Jember and Malang during 2012-2015. Seventy-nine local cultivar names were recorded in the six districts, including local Javanese names and some possible synonyms among the cultivars. Four genomic groups are represented: AA (13), AAA (16), AAB (24) and ABB (16); 10 specimens are uncertain AA/AAA/AAB. Banana cultivar names given by local communities mostly reflect distinct morphological or perceptual characteristics, as well as uses, although some of the names do not refer to appearance or anything at all. Some cultivars were restricted to particular regions. Bananas play important roles in East Javanese socio-economic and cultural life. All parts of the plant are used: for food, fodder, domestic materials, fibers, shelters, ornamentals, medicines, in rituals and ceremonial events and other miscellaneous uses. Banana plants have deep philosophical meaning; their characteristics are associated with the process of life and provide lessons on life ethics. Conservation of local banana cultivars is needed in the face of negative impacts of commercialism. In-situ/on-farm conservation of bananas is a suitable strategy. Conserving the diverse species and varieties of bananas is necessary to maintain their adaptability and resilience to resist biotic and abiotic stresses.

**Key words:** banana, diversity, East Java, ethnobotany, *Musa*, ritual, uses

### INTRODUCTION

Banana (Musaceae) is a fruit plant of worldwide popularity and importance, especially among rural communities. The paleotropical Musaceae family comprises the genera *Musa*, *Ensete* and *Musella*. The Indo-Malesian region is considered the homeland of bananas, both wild species and cultivars. Through processes of domestication, selection and cultivation, humans have spread bananas worldwide throughout the tropics and subtropics (Espino et al. 1992; Kennedy 2008; De Langhe et al. 2009; Kennedy 2009a). Archaeological and biomolecular evidence suggest that bananas began to be domesticated in Southeast Asia at least 5000 years ago (De Langhe et al. 2009; Li et al. 2013).

Ethnobotany depends upon interdisciplinary research. Ethnobotanical researches on bananas have been conducted in different regions with many different perspectives and purposes. These include, for example, linguistic and archaeobotanical perspectives on banana domestication in the Asia-Pacific region (Kennedy 2008, Donohue and Denham 2009), South Asia and East Asia (Fuller and Madella 2009), Africa (Lejju et al. 2006); various uses of banana plants by indigenous people in ancient India (Pushpangadan et al. 1989), Indo-Malesia and the Pacific (Kennedy 2009b); local practices maintaining landrace banana diversity in East Africa Highland (Sato 2009).

Further ethnobotanical studies are urgently needed to improve our understanding of the exact domestication

pathways of popular banana varieties-this is of crucial importance for banana breeding programmes. More work is especially urgent in the crucial and vast area from India, China and mainland Southeast Asia, to the Philippines, Indonesia and New Guinea. This should include biomolecular characterisation (fine sequencing); archaeological excavation and archaeobotanical study (macro and micro fossil banana evidence); more ethnobotanical researches documenting the various uses and cultivation practices of bananas; and in linguistics a much greater understanding of comparative terms for banana plants and plant parts (Daniells et al. 2001; Kennedy 2008; De Langhe et al. 2009).

Being part of the primary center of origin and diversity of bananas, Indonesia has played a significant role in banana history and is a most important region to study. Previous studies show the importance of banana plants in the daily life of people throughout the Indonesian archipelago, notably Papua and Maluku (Edison et al. 1996; Djoht 2002; Edison et al. 2002; Kennedy 2008), North Sulawesi and North Maluku (Hermanto et al. 2012), Central Maluku and Lesser Sunda Islands (Hermanto et al. 2013), Bengkulu (Kasrina and Zulaikha 2013), Purbalingga (Ayuningtyas 2013), Nganjuk (Indraswari 2014), Madura Island (Hapsari et al. 2015a), and Lumajang (Firdausi et al. 2015).

East Java Province was reported as one among the 16 provinces that are centers of banana production in Indonesia (Ministry of Agriculture RI 2015). Setyowati and

Sumiasri (2009) reported their ethnobotanical study which emphasized various uses of bananas in just two districts of East Java, Indonesia, sampling only two villages in Banyuwangi and three villages in Jember. They noted the small sample size and limited perspective, which therefore needed to be complemented and enriched. This paper presents ethnobotanical surveys of bananas in six districts of East Java Province, i.e. Pasuruan, Probolinggo, Banyuwangi, Lumajang, Jember and Malang, including an inventory of local banana cultivars, their naming, morphological appearance, miscellaneous uses, and significance in traditional ritual of East-Javanese culture. This survey records both cultural and biological diversity of bananas in East Java, and contributes to the increasingly urgent global imperative to conserve this diversity.

## MATERIALS AND METHODS

### Study area

East Java Province of Indonesia is geographically located between 111° 0" to 114° 4" East Longitude and 7° 12" to 8° 48" South Latitude, with total area of 47.963 km<sup>2</sup> which includes two main parts, East Java mainland and the Madura Islands. East Java is divided into 29 *kabupaten* (or districts), and 9 *kotamadya* (or cities). The ethnobotanical surveys on bananas were conducted in six districts of East Java Province, Malang, Pasuruan, Probolinggo, Jember, Lumajang and Banyuwangi. All six districts surveyed are located on the East Java mainland (Figure 1). Topography of the East Java mainland varies from plains (83%), hilly to mountainous (11%) and steep land up to 1000 m above sea level (6%), with mostly type D climate according to Schmidt and Ferguson classification, average temperature 22 °C to 33 °C (Central Agency on Statistic of East Java Province 2015).

Most of the population in the six surveyed districts is Javanese. Two minority sub-ethnic groups, Osing and Tenggerese, live in areas of Banyuwangi and Bromo-Tengger-Semeru National Park respectively. In addition to the Javanese there are also Madurese who are scattered throughout the province (Central Agency on Statistic of East Java Province 2014).

### Data collection and analyses

We carried out the field surveys during 2012-2015, with three days fieldwork per district. There were seven to nine villages surveyed per district (Table 1, Figure 1). Villages were selected based on information from local informants, especially banana sellers at the local fruit markets, about banana producing areas around the sites.

This study used a purposive sampling method (Tongco 2007) to gather valuable information from informants regarding their local knowledge of bananas. Snowball sampling was also used to contact hard-to-find key informants such as village leaders, religious leaders, farmers, and older people (Bernard 2002). At least two local informants per village were selected for personal interview, through open-ended, semi-structured interviews (Oishi 2002; Martin 2004; Dickinson 2013). Prior Informed

Consent (PIC) was obtained verbally before commencing each interview (Ellena et al. 2012). Ethical guidelines followed the International Society of Ethnobiology Code of Ethics (2008).

Information gathered included an inventory of local banana cultivar names, synonymies and meanings if available, local knowledge and practices regarding bananas, and reasons for choice to grow particular cultivars. Any miscellaneous uses of parts of banana plants, categorized into root and corm, pseudostem, leaf, and inflorescence as well as fruit, were recorded. The questions also asked about the philosophical meanings and uses of bananas in religious ritual ceremonies. Secondary data obtained from any ethnobotanical reports and references about bananas were also used to enrich the discussion.

This study also includes direct participatory observations. The informants assisted our surveys in farmer's fields, agro-forest landscapes and along the roadsides in the area. Any recognizable banana cultivars were recorded, briefly characterized and documented. Some living banana plants in the form of suckers, and seeds of wild bananas were collected for ex-situ conservation in Purwodadi Botanic Garden, Pasuruan, East Java, Indonesia. Further identifications of genomic group and sub-group of recorded bananas were confirmed using references available, including Simmonds (1959), Espino et al. (1992), Jumari and Pudjoarinto (2000), Valmayor et al. (2000), Daniells et al. (2011), Hapsari et al. (2015b), Hapsari et al. (2015c). Online resources were also used: Banana cultivar checklist (<http://www.promusa.org/Banana+cultivar+checklist>) and *Musa* Germplasm Information System/MGIS (<http://www.cropdiversity.org/mgis/>). In addition, the final identifications were confirmed by banana experts Dr. Jeff Daniells (Department of Agriculture Fisheries, and Forestry, Queensland, Australia) and Dr. Agus Sutanto (Indonesian Fruits Research Institute, Solok, Indonesia).

The banana cultivars recorded in the six districts of East Java, Indonesia were subjected to multivariate analyses to investigate clustering patterns, using statistical software Paleontological Statistics (PAST) version 1.94b. The distribution of banana cultivars was quantified as binary data (present=1, absent=0) prior to analysis. Clustering analysis was conducted using the paired group algorithm and Jaccard similarity index. Principal coordinates (PCo) analysis was conducted using Jaccard similarity index, transformation exponent  $c=2$  (default) at relationship of coordinate 1 to coordinate 3 (Real and Vargas 1996; Hammer et al. 2001).

## RESULTS AND DISCUSSION

### Informants' profile

A total of 105 informants were interviewed in the six surveyed areas (mean value  $\pm$  SD: 17.50 $\pm$ 2.88 per district). Most of the informants were of local Javanese ethnicity and a few were of Madurese descent; none of them were Tenggerese and Osing, since these groups live in isolated areas. More male informants (75%) than females (25%)

were represented, mainly because men were found working on farms during the day, whereas the women were at home. Most informants (76%) were productive working-age farmers between 15-54 years old (21% younger farmers 15-34 y.o. and 55% were middle-aged, 35-54 y.o.). Farmers aged 55 y.o. and above made up 24% (Figure 2). This population profile is comparable to that found throughout dryland rural areas in Indonesia by Winarso (2014). The older informants, both males and females (mean value  $\pm$  SD: 4.17 $\pm$ 2.93), were the key informants for traditional knowledge of bananas. However, the middle-aged farmers were more knowledgeable about banana cultivar diversity, identification and cultivation in their home areas.

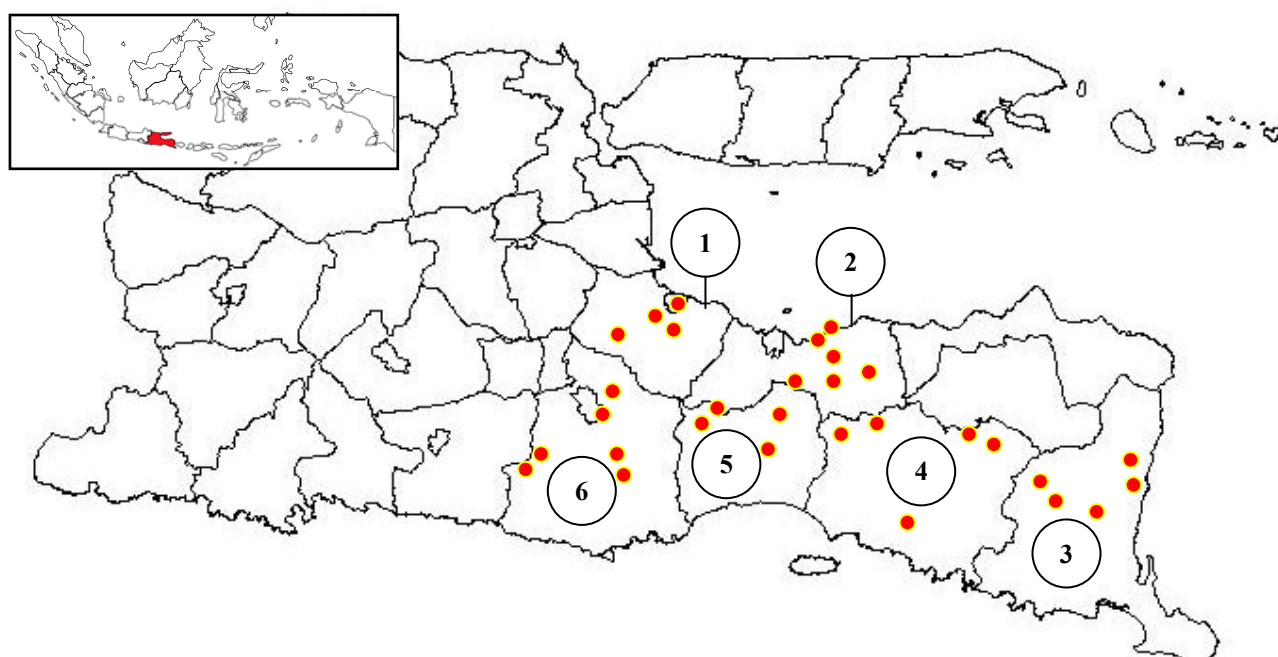
### The names “Gedang” and “Pisang”

The Javanese ethnic group mostly uses Javanese language in everyday speech; but people also understand

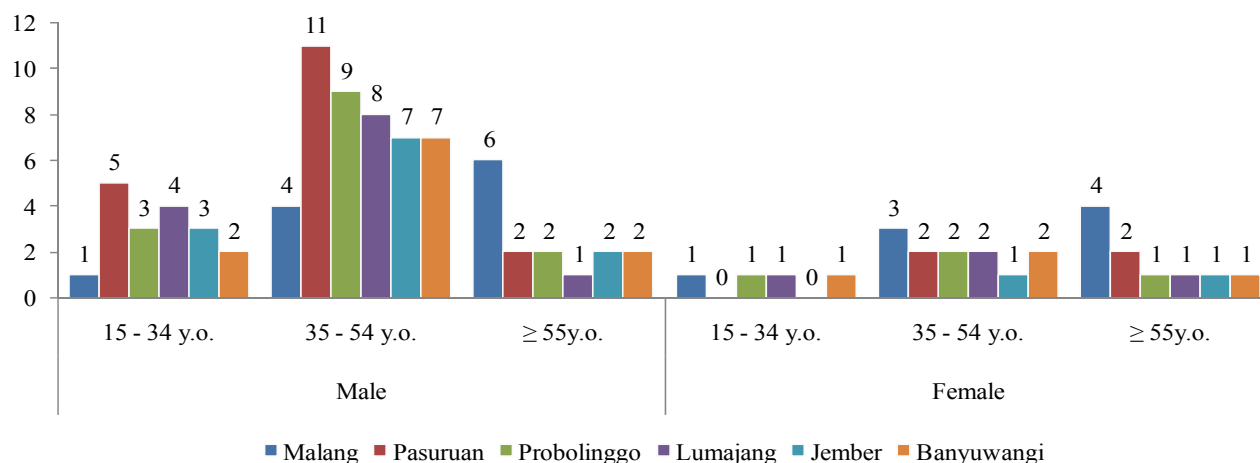
Bahasa Indonesia, the national language. All know the banana names *gedang* (Javanese) and *pisang* (Bahasa Indonesia). Javanese, Madurese and Bahasa Indonesia all belong to the Austronesian family language. The term *pisang*, now widespread in Indonesian and Malay, was an innovation of Proto-Malayic language which spread relatively recently to Malay-influenced areas. *Gedang* is more regionally restricted to Javanese and also Madurese (Donohue and Denham 2009), and has philosophical implications in Javanese. For example, *gedang*, fresh or cooked, are said to be suitable for eating after a heavy meal, “*digeget bar madang*” (Setyowati and Sumiasri 2009). The term *pisang* is now commonly used by people in Java. It also has philosophical implications, since the word “*pisang*” might stand for “*pitadahe gesang*” which means lessons or guidances for life.

**Table 1.** Location of ethnobotanical surveys on bananas in six districts of East Java, Indonesia

| District    | Village (Sub-District)   | Survey schedule |
|-------------|--|-----------------|
| Pasuruan    | Gajahrejo, Sentul, Jatisari (Purwodadi); Tebas (Gondang Wetan); Kejayan (Kurung); Pasrepan, Pohgading, Rejosalam (Pasrepan)  | March 2012      |
| Probolinggo | Pajajaran Kulon, Ketompen (Pajajaran); Bani Wetan (Maron); Condong (Condong); Krucil, Betek (Krucil); Tiris (Tiris)  | April 2012      |
| Banyuwangi  | Kemiren, Taman Suruh (Glagah); Pakistaji, Danasuko (Kabat); Kembiritan (Genteng); Sumbergondo (Glenmore); Barurejo (Kalibaru)  | April 2013      |
| Lumajang    | Kebun Sari (Sumber Suko); Kedungjajang (Kedungjajang); Pakuan, Ambon Jambekubu (Pasrujambe); Wonocempokoayu, Burno (Senduro); Ranu Bedali (Ranuyoso)                     | April 2013      |
| Jember      | Ambulu, Pontang, and ongsari (Ambulu); Tanggul Wetan (Tanggul); Jatiroto (Sumber Baru); Sumberkalong (Kalisat); Lembengan Oloh (Ledok Ombo)                              | May 2013        |
| Malang      | Karangates (Sumberpucung); Sukowilangun, Arjowilangun (Kalipare); Tambakrejo, Sumber Putih (Wajak); Pamotan (Dampit); Ngawonggo, Gunungsari (Tajinan); Asrikaton (Pakis) | April 2015      |



**Figure 1.** Map of location of ethnobotanical surveys on bananas in six districts of East Java, Indonesia. 1. Pasuruan, 2. Probolinggo, 3. Banyuwangi, 4. Jember, 5. Lumajang, 6. Malang



**Figure 2.** Informant profile of the ethnobotanical surveys in six districts of East Java, Indonesia

There are numerous cultivar names and synonyms in different languages and dialects throughout Southeast Asia (Valmayor et al. 2000). In a study of linguistic terms for banana within Island Southeast Asia, Donohue and Denham (2009) have argued that the history domestication and spread of bananas is reflected in the reconstructed basic terms.

Classification and nomenclature of edible bananas have long been a complicated and intractable problem. Knowledge of synonyms is necessary for the regional understanding and communication to facilitate banana commerce. To cope with the problem of highly variable local terms, banana experts have agreed to adopt a three tier system, based on species, genome group, and cultivar, for classifying bananas. Edible bananas are considered to derive from hybridizations among wild diploid subspecies of *Musa acuminata* Colla (A genome) and sometimes also with *Musa balbisiana* Colla (B genome). Morphological traits and molecular methods can be used to identify the genomic groups of bananas. Various levels of ploidy and genomic constitution of bananas include diploid (AA, BB, AB;  $2n=2x=22$ ); triploid (AAA, AAB, ABB;  $2n=3x=33$ ); and tetraploid (AAAA, AAAB, AABB, ABBB;  $2n=4x=44$ ) (Simmonds, 1959; Doležel et al. 1994; Pillay et al. 2000; Valmayor 2000; Daniells et al. 2001; Wong et al. 2002; Nwakanma et al. 2003; De Jesus et al. 2013; Hapsari et al. 2015b).

#### **Inventory of bananas cultivated by farmers in six districts of East Java, Indonesia**

In total, 79 named banana cultivars were recorded in the six districts. Many have local Javanese names and there are possible synonyms among them (Table 2). Morphological characteristics supported identification of four genomic groups: AA (13), AAA (16), AAB (24) and ABB (16); 10 specimens were uncertain AA/AAA/AAB. Since the morphologies are not clear for some cultivars, flow cytometric analysis is needed to identify them (Doležel et al. 1994). The genomic groups include 16 sub-groups; 17 specimens could not be assigned to a sub-group. The AAA group shows high variation, with six sub-groups including Gros Michel, Lakatan, Pisang Nangka, Red/green,

Cavendish and Dwarf Cavendish, and some unclassified as to sub-group.

The greatest number of banana cultivars was found in Pasuruan (38); Malang and Lumajang were equal (33), as were Jember, Banyuwangi and Probolinggo (28). Most sub-groups were represented in all six districts; the districts Pasuruan, Lumajang, Jember and Banyuwangi each had at least one cultivar of a sub-group not represented in the other districts. This distribution might reflect particular local suitability of agro-climatic conditions, as well as consumer preferences. Nine popular cultivars were found in all six districts: Agung (Figure 3.A), Ambon, Candi, Emas, Gajih, Gajih Merah, Gajih Putih, Nangka and Raja. These common bananas are consumer favourites, always available in the local market.

Clustering analysis shows that similarities among the cultivar assemblages of the six districts range from 30% to 53%. Malang and Pasuruan are the most similar, and Lumajang the most different from the other regions (Figure 4.A). The PCo analysis gives a clearer graphic representation of grouping patterns among the six assemblages (Figure 4.B). The eigenvalues of the first three ordinations ranged from 0.17 to 0.33, accounting for 17.74%, 22.54% and 34.27% of the total variance (cumulative 74.55%). The collections from Malang, Pasuruan and Probolinggo were clustered in Group I (similarity 45%), and those from Jember, Banyuwangi and Lumajang in Group II (similarity 30%).

The 79 cultivars were categorized by use of their fruit, 45 as dessert, 22 cooking and 12 dual purpose bananas. Local farmers grow their bananas in homegardens (back and front yards), dry lands, road sides and river banks, for both home consumption and commercial trade. Some commercial banana estates are found in Lumajang District, where there are also many banana traders and small-medium enterprises which process banana products. That is why Lumajang District is called “Kota Pisang” or “Banana City”.

In addition to seedless banana cultivars, wild-type seeded bananas are also cultivated by farmers in East Java, Indonesia, mostly for their beautiful inflorescences and /or decorative leaves (Figure 5). Four species are cultivated as garden ornamentals in scattered areas of the six districts

(Table 3). A fifth, *Musa balbisiana* Colla (Pisang Klutuk) is a common wild-type banana in East Java, also widely cultivated elsewhere, for many purposes including leaves for wrapping, immature fruit and male bud for consumption as side dishes.

#### Local banana cultivar names and synonyms in six districts of East Java, Indonesia

Banana cultivars in East Java, Indonesia show high diversity of morphological characteristics. The most useful standard descriptors are plant stature (pseudostem height and aspect), leaf characters, bunch and fruit characters, male bud and flower characters. The cultivar names given by East Javanese communities mostly reflect distinct morphological or other perceptual characteristics such as taste or smell, as well as utilization. Some of the names, however, do not refer to anything obvious (Table 2, Table 3, Figure 3). A previous inventory of bananas from Madura Island (also part of East Java Province) also showed the same pattern of banana cultivar naming (Hapsari et al. 2015a).

Banana cultivars named after distinct morphological characteristics or appearance include 13 cultivars: Agung (Figure 3.A), Tanduk/Sungu, Berlin Kuning (Figure 3.H), Cebol, Dom, Emas, Gajih Putih, Gajih Merah, Ijo, Kayu, Saba Awu, Saba Putih and Sewu (Figure 3.J), and the wild-type Pisang Klutuk. Those named for taste or smell include Raja Madu, Raja Pakak/Sepet and Wangi. Four cultivars and one wild-type are named for special uses: Emas Kripik, Keripik, Raja Sajen, Tepung and Hias (Table 2, Table 3).

There may be synonyms among the cultivars from the six districts. The same cultivars are often known by different names in different regions. Occasionally, the same name is applied to quite different cultivars. One such example in this study is Pisang Usuk. In Banyuwangi, Usuk refers to a cooking banana from Bluggoe sub-group (Figure 3.F) whilst in Pasuruan it is a dessert banana from Pisang Jari Buaya sub-group (Figure 3.G). Pisang Usuk from Pasuruan is similar to another Indonesian AA cultivar known as Pisang Sapon (Daniells 2016, pers. comm.).

Some minor variations among cultivars may be produced by somatic mutations, retained and spread

through clonal propagation over a time-span of centuries (De Langhe et al. 2009). Such derived cultivars include Agung Talun, Agung Walun, Agung Jawi, Berlin Kuning, Gajih Merah, Gajih Putih, Saba Awu, Saba Putih, Susu Lorek, and many variants of Pisang Raja (Table 2, Figure 3).

#### Various uses of banana plant parts

Bananas are one of the most important commercial crops in the world. They are common, widespread and play an especially significant role in the daily life of rural communities. As well as the fruit, all parts of the plant are useful, for food, fodder, domestic materials, fibers, shelter, ornament, and medicines. They also have a role in ritual and ceremonial events. The literature on myriad uses of Musaceae plant parts throughout Indo-Malesia was reviewed by Kennedy (2009b). She emphasised that this diversity of uses is often obscured by the significance of bananas as an internationally important fruit. But multiple uses over long periods have undoubtedly affected how people have modified and selected the characteristics of banana plants.

The earliest commentary on Indonesian ethnobotany was written in the late seventeenth century by Georg Eberhard Rumpf, better known as Rumphius (Rumphius, 1741). Published in the mid-eighteenth century as *The Ambonese Herbal*, this work includes the first published description of banana landrace diversity, commenting that banana varieties are nowhere more beautiful and luxurious than in Java. There is a whole section on the "Place, Growth, Use, and Virtues of the Musa" (Rumphius, 1741: 13-17). Noting the widespread importance of cooked banana as a weaning food, Rumphius jokes that Indonesians might well claim to be descended from bananas, making a word play of a quote from the Latin poet Ovid by turning reference to the classical Muses to *Musa* (Rumphius, 1741: 14). Recent information on the ethnobotany of bananas in Indonesia is included in Nasution (1991), Edison et al. (1996), Djoht (2002), Edison et al. (2002), Hermanto et al. (2012), Ayuningtyas (2013), Hermanto et al. (2013), Kasrina and Zulaikha (2013), Indraswari (2014), Firdausi et al. (2015) and Hapsari et al. (2015a).

**Table 3.** Wild banana species cultivated by farmers in East Java, Indonesia: Malang, Pasuruan, Probolinggo, Jember, Lumajang and Banyuwangi

| Species name                                      | Vernacular name (Pisang) | English meaning | Morphological feature                         | Uses   | Location  |
|---|--------------------------|-----------------|---|--|---|
| <i>Musa acuminata</i> var. <i>nakaii</i> Nasution | Cici, Becici             | -               | Slender pseudostem, fruit seeded              | Garden ornamental  | Lumajang  |
| <i>Musa velutina</i> H.Wendl. & Drude             | Hias                     | Ornamental      | Attractive red velvety erect inflorescence    | Garden ornamental  | Malang  |
| <i>Musa ornata</i> Roxb.                          | Hias                     | Ornamental      | Attractive purple erect inflorescence         | Garden ornamental  | Malang  |
| <i>Musa balbisiana</i> Colla                      | Klutuk                   | Seeded          | Robust pseudostem, fruit seeded               | Leaves for wrapping, immature fruit and male bud for consumption | Malang, Pasuruan, Probolinggo, Lumajang, Jember, Banyuwangi |
| <i>Ensete glaucum</i> (Roxb.) Cheesman            | Pidak                    | Stamping        | Striking large plant, beautiful inflorescence | Garden ornamental  | Pasuruan  |

**Table 2.** Checklist of bananas cultivated by farmers in six districts of East Java, Indonesia

| Group | Sub-group     | Cultivar name (Pisang) | Synonym                       | English meaning of cultivar name | Use of fruit | Surveyed district |     |     |     |     |     | Notes   |
|-------|---------------|------------------------|-------------------------------|----------------------------------|--------------|-------------------|-----|-----|-----|-----|-----|---|
|       |               |                        |                               |                                  |              | MLG               | PAS | PRB | LMJ | JBR | BWI |   |
| AA    | Inarnibal     | Berlian                | -                             | Diamond                          | Dessert      | -                 | -   | -   | ✓   | -   | -   | Variant of P. Berlin, sour fruit taste                  |
| AA    | Inarnibal     | Berlin                 | Marlin                        | -                                | Dessert      | ✓                 | ✓   | -   | ✓   | ✓   | ✓   | -   |
| AA    | Inarnibal     | Berlin Kuning          | -                             | Yellow Berlin                    | Dessert      | -                 | ✓   | -   | -   | ✓   | ✓   | Variant of P. Berlin, yellowish                         |
| AA    | Inarnibal     | Orlin                  | -                             | -                                | Dessert      | -                 | -   | ✓   | -   | -   | -   | -   |
| AA    | P. Jari Buaya | Dom                    | Jarum                         | Needle                           | Dessert      | -                 | -   | -   | ✓   | -   | -   | Small finger, needle-like                               |
| AA    | P. Jari Buaya | Srinyonya              | -                             | -                                | Dessert      | -                 | -   | -   | ✓   | ✓   | ✓   | -   |
| AA    | P. Jari Buaya | Usuk                   | -                             | -                                | Dessert      | -                 | ✓   | -   | -   | -   | -   | Not the same as #67, in BWI                             |
| AA    | P. Lilin      | Lilin                  | -                             | Candle                           | Dual         | -                 | -   | -   | -   | -   | ✓   | -   |
| AA    | Sucrier       | Emas                   | Mas                           | Gold                             | Dessert      | ✓                 | ✓   | ✓   | ✓   | ✓   | ✓   | Gold skin and flesh                                     |
| AA    | Sucrier       | Emas Kripik            | Mas Alit                      | Kripik=chips, alit=small         | Dual         | -                 | -   | -   | ✓   | -   | -   | Variant of P. Emas, smaller fingers; processed as chips |
| AA    | Sucrier       | Emas Walun             | Mas Ageng                     | Walun, ageng=large               | Dessert      | -                 | -   | -   | ✓   | -   | -   | Variant of P. Emas, bigger fingers                      |
| AA    | *             | Lempeng                | Gaba-gaba                     | -                                | Dual         | -                 | -   | -   | -   | -   | ✓   | -   |
| AA    | *             | Rayap                  | -                             | Termite                          | Dessert      | ✓                 | -   | -   | -   | ✓   | -   | -   |
| AAA   | Cavendish     | Ambon Hong             | -                             | -                                | Dessert      | ✓                 | ✓   | -   | -   | -   | ✓   | Variant of P. Ambon                                     |
| AAA   | Cavendish     | Ambon Kenongo          | Raja Kenanga, Rojo Kenongo    | -                                | Dessert      | ✓                 | ✓   | ✓   | -   | -   | -   | Variant of P. Ambon                                     |
| AAA   | Cavendish     | Cavendish              | Vendis, Pendis                | -                                | Dessert      | -                 | -   | -   | ✓   | -   | -   | -   |
| AAA   | Cavendish     | Kongkong               | Ambon Kongkong                | -                                | Dessert      | -                 | -   | -   | ✓   | -   | -   | Variant of P. Ambon                                     |
| AAA   | Cavendish     | Cebol                  | Raja Pendek                   | Pendek=dwarf                     | Dessert      | -                 | ✓   | ✓   | ✓   | -   | ✓   | Short pseudostem  |
| AAA   | Gros Michel   | Ambon                  | -                             | -                                | Dessert      | ✓                 | ✓   | ✓   | ✓   | ✓   | ✓   | -   |
| AAA   | Gros Michel   | Ijo                    | -                             | Green                            | Dessert      | ✓                 | ✓   | ✓   | ✓   | -   | ✓   | Peel of ripe fruit is green                             |
| AAA   | Lakatan       | Barangan               | -                             | -                                | Dessert      | -                 | -   | -   | -   | ✓   | -   | -   |
| AAA   | P. Nangka     | Nangka                 | Raja Nangka                   | Jackfruit                        | Cooking      | ✓                 | ✓   | ✓   | ✓   | ✓   | ✓   | -   |
| AAA   | Red/green     | Bug                    | Embug, Buah, Raja Molo, Lombu | -                                | Dessert      | ✓                 | ✓   | ✓   | -   | ✓   | -   | -   |
| AAA   | Red/green     | Emasan                 | -                             | Golden                           | Dessert      | -                 | ✓   | ✓   | -   | -   | -   | Not the same as Emas/Sucrier                            |
| AAA   | Red/green     | Kidang                 | Musang, Museng, Moseng        | Kidang=deer; musang=weasel       | Dessert      | ✓                 | ✓   | ✓   | ✓   | ✓   | -   | -   |
| AAA   | Red/green     | Salik                  | -                             | -                                | Dessert      | ✓                 | -   | -   | -   | -   | -   | -   |
| AAA   | *             | Kayu                   | -                             | Wood                             | Dual         | -                 | ✓   | ✓   | ✓   | ✓   | ✓   | Fruit dark brown like wood                              |
| AAA   | *             | Santen                 | Raja Santen                   | Santen=coconut milk              | Dual         | ✓                 | ✓   | ✓   | -   | ✓   | ✓   | -   |
| AAA   | *             | Selendang              | -                             | Scarf                            | Dessert      | ✓                 | -   | -   | -   | ✓   | -   | -   |
| AAB   | Mysore        | Porem                  | -                             | -                                | Dessert      | -                 | ✓   | -   | -   | -   | -   | -   |
| AAB   | P. Raja       | Pulut                  | Raja Pulut                    | Pulut=sticky sap                 | Dessert      | ✓                 | ✓   | -   | -   | -   | -   | -   |
| AAB   | P. Raja       | Raja                   | Raja Legi, Raja Temen         | Raja=king, temen=true            | Dual         | ✓                 | ✓   | ✓   | ✓   | ✓   | ✓   | True P. Raja  |
| AAB   | P. Raja       | Raja Bulu              | Raja Madu                     | Bulu=feather, madu=honey         | Dessert      | -                 | -   | -   | -   | ✓   | -   | Variant of P. Raja, sweeter taste like honey            |
| AAB   | P. Raja       | Raja Kriak             | -                             | -                                | Dessert      | ✓                 | ✓   | -   | -   | -   | -   | Variant of P. Raja                                      |
| AAB   | P. Raja       | Raja Kul               | Raja Talun                    | -                                | Dessert      | ✓                 | ✓   | ✓   | -   | -   | -   | Variant of P. Raja                                      |
| AAB   | P. Raja       | Raja Lumut             | -                             | Lumut=moss                       | Dessert      | -                 | ✓   | ✓   | ✓   | -   | -   | Variant of P. Raja, moss-green peel when ripe           |
| AAB   | P. Raja       | Raja Pakak             | Raja Sepet                    | Pakak, sepet=astringent          | Cooking      | -                 | ✓   | -   | -   | -   | -   | Variant of P. Raja, astringent taste                    |

|              |          |             |                              |                              |         |           |           |           |           |           |           |   |   |   |   |  |
|--------------|----------|-------------|------------------------------|------------------------------|---------|-----------|-----------|-----------|-----------|-----------|-----------|---|---|---|---|--|
| AAB          | P. Raja  | Raja Sajen  | Rojo Talun                   | Sajen=offerings              | Dessert | ✓         | -         | -         | -         | -         | -         | - | - | - | - | Variant of P. Raja, used for offerings   |
| AAB          | P. Raja  | Raja Sisir  | -                            | Sisir=comb                   | Dessert | -         | -         | -         | -         | ✓         | -         | - | - | - | - | Variant of P. Raja                       |
| AAB          | P. Raja  | Raja Sri    | -                            | -                            | Dual    | -         | -         | -         | -         | -         | -         | ✓ | - | - | - | -  |
| AAB          | P. Raja  | Raja Wlingi | -                            | -                            | Dessert | -         | ✓         | -         | -         | -         | -         | - | - | - | - | Variant of P. Raja                       |
| AAB          | Plantain | Agung       | -                            | Large                        | Cooking | ✓         | ✓         | ✓         | ✓         | ✓         | ✓         | ✓ | ✓ | ✓ | ✓ | very large fingers                       |
| AAB          | Plantain | Agung Jawi  | Agung Jawa                   | -                            | Cooking | -         | -         | -         | ✓         | -         | -         | - | - | - | - | Variant of P. Agung                      |
| AAB          | Plantain | Agung Talun | -                            | Talun=real                   | Cooking | -         | -         | -         | ✓         | -         | -         | - | - | - | - | Variant of P. Agung                      |
| AAB          | Plantain | Agung Walun | -                            | -                            | Cooking | -         | -         | -         | -         | ✓         | -         | - | - | - | - | Variant of P. Agung                      |
| AAB          | Plantain | Byar        | Tanduk, Sungu                | Tanduk/sungu=horn            | Cooking | ✓         | ✓         | ✓         | -         | ✓         | -         | - | - | - | - | Horn plantain                            |
| AAB          | Plantain | Candi       | -                            | Temple                       | Cooking | ✓         | ✓         | ✓         | ✓         | ✓         | ✓         | ✓ | ✓ | ✓ | ✓ | French plantain                          |
| AAB          | Silk     | Grito       | Songgro, Songgroito          | -                            | Dessert | -         | ✓         | ✓         | -         | -         | -         | - | - | - | - | -  |
| AAB          | Silk     | Salah Roso  | Sembur, Raja Sere            | -                            | Dessert | ✓         | ✓         | -         | -         | -         | -         | - | - | - | - | -  |
| AAB          | Silk     | Susu        | Endhog, Telor, Tepong        | Susu=milk; endhog, telor=egg | Dessert | ✓         | ✓         | ✓         | -         | -         | ✓         | ✓ | ✓ | ✓ | ✓ | -  |
| AAB          | Silk     | Susu Lorek  | -                            | -                            | Dessert | -         | ✓         | -         | -         | -         | -         | - | - | - | - | Variant of P. Susu                       |
| AAB          | *        | Brentel     | -                            | -                            | Dessert | -         | -         | -         | ✓         | -         | -         | - | - | - | - | -  |
| AAB          | *        | Sewu        | Seribu, Raja Seribu          | Thousands                    | Dessert | -         | ✓         | -         | -         | -         | ✓         | - | - | - | - | Many fruits on the bunch                 |
| AA/AAA/AAB   | ?        | Celakat     | -                            | -                            | Dessert | -         | -         | -         | -         | -         | -         | - | - | ✓ | - | -  |
| AA/AAA/AAB   | ?        | Dulang      | -                            | Tray                         | Dual    | ✓         | -         | -         | -         | -         | -         | - | - | - | - | -  |
| AA/AAA/AAB   | ?        | Kapri       | -                            | Snow peas                    | Dessert | -         | -         | -         | -         | -         | ✓         | - | - | - | - | -  |
| AA/AAA/AAB   | ?        | Kopyok      | -                            | Mixing                       | Dessert | -         | -         | -         | ✓         | -         | -         | - | - | - | - | -  |
| AA/AAA/AAB   | ?        | Manurung    | -                            | -                            | Dual    | ✓         | -         | -         | -         | -         | -         | - | - | - | - | -  |
| AA/AAA/AAB   | ?        | Samarinda   | -                            | -                            | Dessert | -         | -         | -         | ✓         | -         | -         | - | - | - | - | -  |
| AA/AAA/AAB   | ?        | Siwalan     | -                            | -                            | Dessert | -         | -         | -         | -         | ✓         | -         | - | - | - | - | -  |
| AA/AAA/AAB   | ?        | Wangi       | -                            | Fragrant                     | Dessert | -         | -         | ✓         | -         | -         | -         | - | - | - | - | Sweet fragrant fruit                     |
| AA/AAA/AAB   | ?        | Welut       | -                            | Eel                          | Dual    | -         | -         | -         | -         | -         | -         | - | - | ✓ | - | -  |
| AA/AAA/AAB   | ?        | Wringinan   | -                            | -                            | Dessert | -         | -         | -         | ✓         | -         | -         | - | - | - | - | -  |
| ABB          | Bluggoe  | Saba        | -                            | -                            | Cooking | ✓         | ✓         | -         | ✓         | ✓         | ✓         | ✓ | ✓ | ✓ | ✓ | -  |
| ABB          | Bluggoe  | Saba Awu    | -                            | Awu=grey                     | Cooking | ✓         | ✓         | -         | -         | -         | -         | - | - | - | - | Grey waxy fruit peel, ?Silver Bluggoe    |
| ABB          | Bluggoe  | Saba Putih  | -                            | Putih=white                  | Cooking | -         | ✓         | -         | -         | -         | ✓         | - | - | - | - | White waxy fruit peel, ?Blue Java        |
| ABB          | Bluggoe  | Usuk        | -                            | -                            | Cooking | -         | -         | -         | -         | -         | -         | - | - | ✓ | - | Not the same as #7, in PAS               |
| ABB          | P. Awak  | Awak        | -                            | -                            | Dual    | -         | -         | -         | -         | -         | -         | - | - | ✓ | - | -  |
| ABB          | P. Awak  | Bawak       | -                            | -                            | Dual    | ✓         | -         | -         | -         | -         | -         | - | - | - | - | -  |
| ABB          | Saba     | Gajih       | Kepok, Bung, Ebung           | Gajih=fat                    | Cooking | ✓         | ✓         | ✓         | ✓         | ✓         | ✓         | ✓ | ✓ | ✓ | ✓ | -  |
| ABB          | Saba     | Gajih Bali  | Kepok Bali, Estrali, Ustrali | -                            | Cooking | -         | -         | -         | ✓         | -         | -         | - | - | - | - | Variant of P. Kepok                      |
| ABB          | Saba     | Gajih Merah | Kepok Merah                  | Merah=red                    | Cooking | ✓         | ✓         | ✓         | ✓         | ✓         | ✓         | ✓ | ✓ | ✓ | ✓ | Variant of P. Kepok, pinkish flesh       |
| ABB          | Saba     | Gajih Putih | Kepok Putih                  | Putih=white                  | Cooking | ✓         | ✓         | ✓         | ✓         | ✓         | ✓         | ✓ | ✓ | ✓ | ✓ | Variant of P. Kepok, white flesh         |
| ABB          | Saba     | Keripik     | -                            | Chips                        | Cooking | -         | -         | ✓         | -         | ✓         | -         | - | - | - | - | Fruit used for chips                     |
| ABB          | Saba     | Satroli     | -                            | -                            | Cooking | -         | -         | ✓         | -         | -         | -         | - | - | - | - | -  |
| ABB          | Saba     | Sepet       | -                            | Astringent                   | Cooking | ✓         | -         | -         | -         | -         | -         | - | - | - | - | Astringent fruit                         |
| ABB          | Saba     | Sri         | -                            | -                            | Cooking | -         | -         | -         | -         | -         | -         | - | - | - | - | -  |
| ABB          | Saba     | Tajinan     | -                            | -                            | Cooking | -         | -         | -         | -         | -         | -         | - | - | ✓ | - | Male bud is absent                       |
| ABB          | Saba     | Tepung      | -                            | Flour                        | Cooking | -         | -         | ✓         | -         | -         | -         | - | - | - | - | Fruit processed into flour for baby food |
| <b>Total</b> |          |             |                              |                              |         | <b>33</b> | <b>38</b> | <b>28</b> | <b>33</b> | <b>28</b> | <b>28</b> |   |   |   |   |  |

Note: MLG=Malang; PAS=Pasuruan; PRB=Probolinggo; LMJ=Lumajang; JBR=Jember; BWI=Banyuwangi; P.=Pisang; ?=doubtful classification; \*=not sub-grouped



There is a large literature which describes therapeutic uses of banana plant parts in Ayurvedic and other ancient traditions, and which assesses the efficacy of these uses using modern analytical techniques. A recent review of literature includes Portuguese, Indian and Thai studies on the evidence for therapeutic biological activity of *Musa* spp, and suggests that various banana plant parts have antimicrobial, wound-healing, antioxidant and anti-helminthic activity (Dos Santos et al. 2012). Some further examples are cited below.

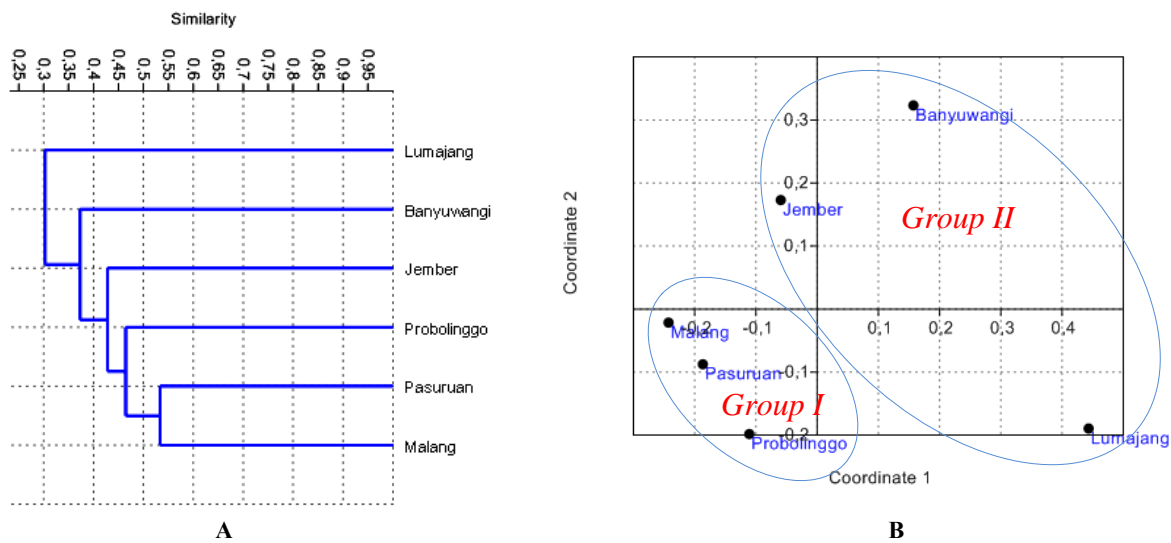
#### Roots and corm

At the base of the banana plant, the rhizome is a thickened part of the true stem. Its underground growth is horizontal, and it produces roots from multiple basal nodes, and lateral suckers. This part of the plant, often called the corm, is used by farmers as fodder for cattle. Water that comes from it when the plant is cut is used by East Javanese informants as a hair tonic and for medicinal uses such as treatment for stomach ache, dysentery and urinary tract infection.



**Figure 3.** Some local banana cultivars in six districts of East Java, Indonesia: A. Pisang Agung; B. Pisang Tajinan; C. Pisang Lempeneng; D. Pisang Srinonyanya; E. Pisang Kidang; F. Pisang Usuk (Cooking banana); G. Pisang Usuk (Dessert); H. Pisang Berlin; I. Pisang Berlin Kuning; and J. Pisang Sewu





**Figure 4.** The distribution of banana cultivars present in six districts of East Java, Indonesia: A. Clustering analysis, B. Principal coordinates analysis

In Indian and Chinese traditional medicine, the extract of roots and corms of certain bananas combined with other ingredients has value in treating inflammation, pain, snake-bite, ulcers, diabetes, piles, food poisoning, diarrhoea, dysentery, kidney stones, menstrual disorder, venereal diseases, lowering blood sugar and lipid levels, to induce abortion, cure pyorrhoea and tighten gums around loose teeth (Pushpangadan et al. 1989; Kumar et al. 2012; Venkatesh et al. 2013; Dixit et al. 2014). Banana roots possess strongly astringent and anti-parasitic properties, and are used to treat pulmonary disease (Prasobh and Revikumar 2011).

#### *Pseudostem*

Pseudostems of banana plants are commonly utilized as bases to hold traditional Javanese leather puppets behind the screen during shadow-play performances (*wayang kulit*) and in making flower decorations. They may also form the base of temporary cooking stoves with firewood for festive occasions. A single banana pseudostem or several fastened together can be used as a raft to cross small rivers. Fresh sheaths pulled from a pseudostem are used to shade newly planted seedlings. Decomposed pseudostem can be used as fertilizer. In Lumajang District, the inner skin of pseudostem sheath is used for wrapping *tempeh* (fermented soybeans) instead of the more common leaf wrapping (Figures 4.B and 4.C).

Experimental studies have suggested that pseudostem sap possesses haemostatic and antioxidant properties, has both hyper- and hypoglycemic effects, is diuretic, an antidote for snake bite and cures kidney stones (Singh et al. 2007; Pothavorn et al. 2010; Prasobh and Revikumar 2011; Weremfo et al. 2011; Onyenekwe et al. 2013; Ponnambalam and Sellappan 2014). The pseudostem sap can also be used in dyeing cloth, for colour and as a mordant (fixative). The use of banana sap is an attractive alternative to synthetic dyes, mordants and other additives,

which are imported and therefore relatively expensive (Pothavorn et al. 2010; Dzomeku and Boateng 2013; Barhanpurkar et al. 2015). Analysis of banana sap from wild banana species and cultivars, using high-performance liquid chromatography–electrospray ionization–mass spectrometry (HPLC-ESI-MS) indicated the presence of phenolic and aromatic amino compounds, which varied among the samples tested, and which might account for medicinal and other useful properties (Pothavorn et al. 2010).

#### *Leaves*

Leaves of bananas are a commercial commodity, always available in local markets of the six surveyed areas (Figure 5.A). They are commonly used as domestic wrapping material. Leaves of *M. balbisiana* (Pisang Klutuk) and hybrids with two B genomes (Gajah/Kepok, Saba, etc.) are preferred, because they are thick, wide, not easily torn, are a dark green color, and give good flavor to food. Javanese side dishes use banana leaf wrappers in many unique forms and techniques. Examples are *botok*/fish cake (Figure 5.D), *pepes*/fish cake (Figure 5.E), *lontong*/rice cake (Figure 4.F), *lemper* (glutinous rice cake), *arem-arem*, *bugis*, *lopis*, *lemet* (cassava cake). Ashes of burned leaves are used to color traditional glutinous rice cake (*ongol-ongol*) black. Moreover, banana leaves are commonly used as plates for traditional meals.

Banana leaf sheaths and laminae can be used as umbrellas in light rain or for shade, and as fodder for livestock. The petiole and pseudostem sheath can be made into many creative children's toys. Fibers of petiole and pseudostem sheath are used as rope or string, for example to tie up live crabs or firewood.

Sap from the leaves is used medicinally as a remedy for red eyes, and young leaves for skin swelling. According to Puspangadan et al. (1989), banana leaves are used by the tribes of India for bandaging cuts, blisters, ulcers and

burns, and leaf ashes dissolved in water are given to patients to relieve acidity, indigestion and flatulence. Nasution (2001) noted that in North Sulawesi, people used the tip of a leaf shoot to smooth the sole of the foot.

### Fruit

Fruit is the main commercial commodity yielded by banana plants. Mostly banana farmers sell their fruits in the local market, as well as consuming them at home. Bananas fruit all year round, and are available during the dry season. They may become an alternative staple food when other food is in short supply. The socio-economic importance of banana has increased recently among the rural community. This is due not only to the economic value of the fruit, but also because its nutritional value and the diverse uses of the processed fruit are now well recognized (Hapsari 2011).

Bananas are high in carbohydrates, vitamin C and potassium; they have medium protein and low fat levels, with variation between cultivars. 100 grams of ripe banana pulp provides 73.43 to 148.8 calories. Due to their high nutrient value, bananas are nutritious food recommended for people of all ages, but especially for babies, and also as diet food for adults. However, consumption must be limited for diabetics and patients with kidney problems, due to high sugar and potassium content (Hapsari and Lestari 2016).

East Javanese people use some banana cultivars medicinally: for example, Pisang Emas to cure yellow and typhoid fever; Pisang Klutuk to cure diarrhea. Banana fruit are widely considered to have an aphrodisiac effect. A review of phytochemical and pharmacological research cites evidence that banana pulp contains tryptophan and serotonin, among other compounds (Imam and Akter 2011). Such compounds might account for the sense that bananas promote relaxation, improve the mood and cause happy feelings.

The fruit of bananas can be eaten raw as dessert or cooked. Eaten fresh, the ripe flesh of dessert bananas contains carbohydrates in form of sugars that taste sweet. In cooking bananas, the ripe flesh contains starch which must be cooked to become palatable (Gibert et al. 2009). However, banana cultivars can also be dual purpose, the fruits consumed either fresh or cooked. Forty-six of the cultivars of the six surveyed areas of East Java are classified as dessert bananas, 25 are cooking bananas and 13 are dual purpose (Table 2). Pisang Ambon, Emas and Berlin are popular and preferred dessert bananas. Pisang Gajih/Kepok and Candi are the most preferred cooking bananas.

Techniques for cooking bananas are simple, such as boiling, steaming, roasting, frying and sun-drying. More advanced processing techniques are now available, such as vacuum frying to make better quality chips. There are many local snacks made from bananas, which are becoming commercial products of home industry, for example *sale* (dried banana), chips, *getuk*, *ledre*, *nagasari*, banana cake. Unripe bananas can be processed into flour for baby food and to make snacks. In Probolinggo District, Pisang Tepung (*tepfung*=flour) is specifically used to make flour. Unripe fruit of wild seeded Pisang Klutuk is

sometimes added to popular side dishes in East Java, for example *Rujak Cingur*.

In addition to pulp, banana peels are also used. Peel of immature and mature fruit is used as fodder for livestock. The inside of the mature fruit peel can be used as foot skin moisturizer. Study of peel extracts of nine Indian banana varieties showed significant antioxidant and other phytochemical activity (Baskar et al. 2011).

### Inflorescences

The attractively-coloured inflorescences of wild banana plants make them valued ornamentals in front and back yards of home gardens and along roadsides (Table 3, Figure 6). Pisang Cici (*M. acuminata* var. *nakaii*) has purplish brown pigmentation and brown hairs on rachis and fruit (Figure 6.A.; Nasution, 1991). Pisang Hias (*M. velutina* and *M. ornata*) belong to section Rhodoclamys, which is characterized by upright inflorescences with few flowers to a bract and brightly coloured bracts. *M. velutina* has pink bracts and pink velvety fruits (Figure 6.B) while *M. ornata* has sweet pink or lilac bracts and small green upright fruits (Figure 6.C; Häkkinen and Väre 2008; Joe and Sabu 2016). Pisang Pidak (*Ensete glaucum*) is ornamental because of its statuesque pseudostem, conical, bluish and powdery, up to 4 m tall with mostly persistent green bracts (Figure 6.D; Majumdar et al. 2013; Joe and Sabu 2016).

The male bud or *jantung* of the banana inflorescence is commonly eaten in rural communities as a side dish. First boiled to reduce its astringent taste, it is then cooked as a vegetable served with peanut sauce as *pecel*, or with seasoned grated coconut as *urap*, or with coconut milk as *gulai sayur*. Chemical analysis of *M. acuminata* inflorescences (male bud and bracts) by Fingolo et al. (2012) revealed their considerable nutritional value, with high potassium and fiber and low calories. However, the male bud of *M. balbisiana*, rather than *M. acuminata*, is preferred by East Javanese because of its less astringent taste.

### Bananas and traditional rites in East Javanese culture

Banana plants have significant roles in traditional Javanese rituals and customs. The plant has deep symbolic meaning, its characteristics associated metaphorically with the process of life and thereby providing lessons on ethics (Solikin 2010). It is a cosmopolitan plant which can grow in variable conditions: therefore, we should be easy-going and adapt well to any environment. All parts of the banana plant are useful: so we should always be useful and helpful to others, aware of our flaws and mindful of our existence in this life. The banana is a monocarpic plant, flowering only once in its lifetime, setting seeds (if capable) and then dying. Thus, we should never give up on our final goal. A fruiting banana plant is a symbol of high fertility, good harvest and hopes of prosperity.

Because of its deep philosophical association with life, the banana plant is one among the obligatory components of offerings and decorations in the ritual ceremonial activities marking every life stage, from pregnancy, birth, circumcision, marriage until the funeral. Banana plants are

present in thanksgiving ceremonies, such as those for the harvest season, village clearance (Figure 7), house warming, or even a career promotion; in worship or religious events, such as the Tenggerese Kasada festival (Pramita et al. 2013), and the Javanese thanksgiving or *slametan*, the most significant rite which marks every important moment in Javanese society (Koentjaraningrat, 1984). The banana parts most used are fruit (a hand or two hands) or a whole fruited plant (Table 4). Banana leaves are also used as plates for food offerings, sometimes folded into containers called *takir*.

Pisang Raja is most valued for ritual activities, especially Raja Pulut. In Malang District, Pisang Raja Sajen is specifically used for offerings or *sajen*. When Pisang Raja cannot readily be found in the market, it can be replaced with any other cultivar of banana (with certain limits). *Raja* means king, symbolising hopes for the happy, successful prosperity of kings and to become a wise and

righteous person. Likewise, *pulut* means sticky sap, symbolises the wish to be free from harms (Endraswara 2006; Solikin 2010).

#### Conservation of banana cultivar germplasm

This study has shown that there are many cultivated varieties of bananas in East Java, Indonesia, some of which are indigenous and/or endemic in particular regions. Current commercialization and the introduction of high-yielding varieties of bananas will lead to the disappearance of local, native and unpopular banana cultivars, which will be replaced by common commercial varieties grown in monocultures. Some farmers in Lumajang District have already experienced such monocultural farming. Farmers are tending to grow marketable cultivars. Monocultures are particularly vulnerable to fluctuating environmental and climatic conditions as well as to outbreaks of pests and diseases.

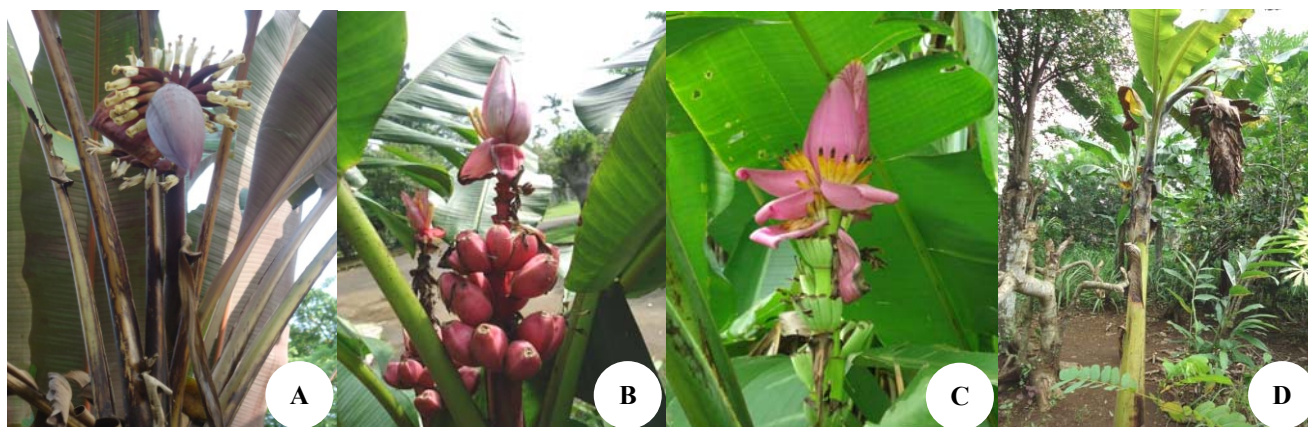
**Table 4.** The uses of bananas in traditional ritual ceremonies of East Javanese culture, Indonesia

| Rituals                                | Plant parts used                                 | How used  |
|--|--|---|
| Pregnancy                              | A finger or a hand of fruit                      | As offering   |
| Birth                                  | A finger or a hand of fruit                      | As offering   |
| Circumcision                           | A finger or a hand of fruit                      | As offering   |
| Wedding                                | Whole fruited plant, two hands of fruit          | Two bunches of banana positioned in the main gate of wedding ceremony as decoration, two hands of Pisang Raja as offering from the groom to the bride |
| House-building                         | Sucker   | Sucker positioned in the pillar of the house as decoration  |
| Funeral                                | Whole fruited plant                              | Whole fruited banana plant laid out on the new burial ground of single/not married dead person  |
| Any thanksgiving                       | Whole fruited plant, a finger or a hand of fruit | As offering and decoration  |
| Kasada (Tenggerese religious ceremony) | A bunch and /or a hand of fruit                  | As offering and decoration  |



**Figure 5.** A. Banana leaves for sale in the market at Malang; Various uses of banana plants for food packaging: B. Pseudostem sheath for tempeh packaging in Lumajang; C. Banana leaf for tempeh packaging in Malang; Traditional foods wrapped with banana leaf: D. *Botok*, E. *Pepes*, and F. *Lontong*.





**Figure 6.** Wild-type banana plants grown as garden ornamentals found in six districts of East Java, Indonesia: A. *M. acuminata* var. *nakaii*; B. *M. velutina*; C. *M. ornata*; and D. *E. glaucum*



**Figure 7.** Village thanksgiving ritual in Pasuruan District, East Java using two bunches of Pisang Raja for decoration

In recent years, the productivity of small-holder banana farms has been declining, which has been attributed to soil nutrient depletion (Bekunda, 1999), pest and disease outbreaks such as *Fusarium* and bacterial wilts, bunchy top disease and sigatoka (Kusumoto et al. 2010; Prasetyo and Sudiono 2010; Hapsari and Masrum 2012). This decline produces both ecological and socio-economic imbalances. Therefore, immediate steps should be taken for the preservation and conservation of local banana cultivars.

Bananas play important roles in the socio-economic and cultural life of East Javanese communities. Traditional knowledge is an important component in improving the management of natural resources and practices relating to the protection of ecosystems and species (Shackeroff and Campbell 2007). In situ/on-farm conservation is a suitable,

self-sustainable strategy, capable of adapting to and mitigating climate change, by helping to maintain an integrated system of diversified food production and land use (Sthapit et al. 2009; Bellon and van Etten 2014). In the case of banana farming, using diverse species and varieties enhances their adaptability, resilience and capacity to withstand biotic and abiotic stresses such as changing environmental and climatic conditions, and pest and disease outbreaks.

Bananas in combination with tree crops are potentially an important component of agroforestry, home garden and mixed farming systems, to rehabilitate and reforest landscape, to decrease carbon emissions to the atmosphere from biomass and C-stocks and to meet the economic needs of local communities. Previous study showed that



banana plants store more carbon (0.98 tonnes/ha) than cassava (0.5 tonnes/ha) and *Imperata* grassland (0.7 tonnes/ha) (Danarto and Hapsari 2015). Empowerment of farming communities is essential for effective in situ/on-farm conservation, as the process relies upon local level decision-making about management of genetic resources (Sthapit et al. 2009).

To complement in situ/on-farm conservation, ex-situ conservation is also needed. Whereas on-farm conservation maintains the evolutionary processes linking crops and their management regimes, that generate new potentially useful genetic variation, *ex situ* conservation maintains the results of these processes (the specific genes and genotypes sampled at a particular point in time (Bellon and van Etten 2014). From this study (2012-2015) we obtained 68 living banana cultivars for ex-situ conservation in Purwodadi Botanic Garden, Pasuruan, East Java, Indonesia.

### ACKNOWLEDGEMENTS

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