J. Trop. Agric. and Fd. Sc. 38(1)(2010): 89–95

Distribution and diversity of *Mangifera* species on farm in Malaysia

(Taburan dan kepelbagaian spesies *Mangifera* di halaman rumah di Malaysia)

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Keywords: diversity, distribution, *Mangifera*, on farm conservation

Abstract

Surveys on *Mangifera* species were carried out in 25 home gardens or orchards in each of 25 districts in 11 states in the country. A total of 14 *Mangifera* species were found to be cultivated or semi-cultivated in the home gardens or orchards. Each home garden had 1–5 *Mangifera* species. The state of Sarawak showed the highest species richness S = 11 which accounted for 79% of the observed diversity. However, species diversity is low (Shannon Diversity Index H' = 0.484) due to the uneven distribution of the species. Johor showed the highest species diversity H' = 1.649, followed by Sabah H' = 1.592, Selangor H' = 1.453, Terengganu H' = 1.305 and Pahang H' = 1.252. Four *Mangifera* species, *M. indica, M. odorata, M. foetida* and *M. caesia* were common, being cultivated in all the 11 studied states in the country. *Mangifera pajang* (bambangan) is endemic to Sarawak and Sabah. *Mangifera* species that could be considered as very rare as they occurred only in very few areas and in few number of trees were *M. longipetiolata* (sepam) (0.004%), *M. torquenda* (kemantan) (0.015%), *M. microphylla* (raba) (0.011%), *M. griffithii* (rawa) (0.174%), *M. kemanga* (kemang) (0.019%) and *M. lagenifera* (lanjut) (0.022%). *Mangifera torquenda* and *M. microphylla* were found only in Sarawak.

Introduction

The genus *Mangifera* consists of about 40 species (Kochummen 1989; 1996) distributed from India and Sri Lanka in the West, throughout Malaysia and to the Philippines and Papua New Guinea in the East. Thirty species occur in Malaysia with 15 species found in Peninsular Malaysia and 16 species in Sabah and Sarawak (Kochummen 1989; 1996). Of these, three species *M. gracilipes*, *M. khoonmengiana* and *M. pajang* are endemic to Sabah and Sarawak. Of the 12 species reported to be cultivated, eight are still found in the wild (Kosterman and Bompard 1993; Kochummen 1996).

Most of the *Mangifera* species have edible fruits. The fruits are sweet to sour in taste, either consumed fresh or processed into jams or jellies. Young fruits can be made into pickles, chutneys or dried as preserves and also can be cooked as dishes.

The natural habitat of the *Mangifera* species is the tropical rainforest where they are widely distributed from lowland to lower montane forest at 1,800 m a.s.l.

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(Kochummen 1996). In the primary lowland rain forest in Peninsular Malaysia, Saw et al. (1991) recorded 12 *Mangifera* species in a 50 ha plot at Pasoh, Negeri Sembilan, whereas Salma et al. (2000) noted only *M. quadrifida* as a common species in the Belum forest, Temenggor, Perak. However, *Mangifera* species are also being cultivated or semi-cultivated in the home gardens or orchards (Salma et al. 2006a; 2006b) in Jerantut and Kuala Lipis (Pahang), Bandar Sri Aman and Sibuti (Sarawak), Papar, Kampong Lingkungan and Kg. Pintas (Sabah).

Home gardens or orchards constitute important agricultural systems and harbour many indigenous species, varieties, landraces and even rare fruit species. These diverse and rare fruit tree species, including *Mangifera* species, are normally grown in a mixed orchard or integrated with some commodity crops such as cocoa or rubber in an agroforestry system which contributes not only to people's livelihoods but also towards a sustainable ecosystem (Salma et al. 2006a). In addition, the communities also hold enormous indigenous knowledge on the conservation and use of the traditional fruit species (Salma et al. 2006b).

Mangifera indica, the common commercial mango, is widely cultivated and extensively researched on. Unfortunately, the information on the distribution and diversity of its wild relatives is much less comprehensive. In view of this, surveys on the distribution, diversity and the use of the rare fruit species were carried out in the home gardens or orchards throughout the country. The major rare fruit species included in the survey are listed in *Appendix 1*. However, this paper only reports the distribution and diversity of the *Mangifera* species grown in the home gardens or orchards.

Materials and methods

Surveys of underutilized fruits in home gardens or orchards and interviews with the households were carried out in 25 selected districts from only 11 states in the country (*Table 1*). In each district, 25 home gardens or orchards were surveyed. The *Mangifera* species available in the home gardens or orchards, their frequency as well as their uses were recorded.

The distribution of the *Mangifera* species was mapped using DIVA-GIS. While the Shannon Diversity index, richness and evenness were analysed using Multi-Variate Statistical Package (MVSP).

Results and discussion

A total of 14 *Mangifera* species were found to be cultivated or semi-cultivated in the home gardens or orchards from the surveyed districts in the 11 states (*Table 2*). The number of cultivated *Mangifera* species enumerated was found to be greater than that reported by Kosterman and Bompard (1993) which could probably due to the greater areas covered in the survey. Of these, eight species were similar and another six were new species recorded to be found in the home gardens or orchards. These were *M. kemanga, M. microphylla, M. laurina, M. torquenda, M. longipetiolata* and *M. odorata*. Besides *M. laurina* and *M. odorata* which were cultivated by the farmers, the other four species were not of recent cultivation but they were old trees (more than 100 years old) being left over

Table 1. Districts and states of areas surveyed

States	Districts
Kelantan	Jeli, Tenah Merah
Johor	Kluang, Pontian
Negeri Sembilan	Kuala Pilah, Jempol
Selangor	Hulu Selangor, Ulu Langat
Perak	Grik, Kuala Kangsar
Melaka	Alor Gajah
Pahang	Kuala Lipis, Jerantut
Terengganu	Setiu, Kemaman
Kedah	Sik, Kuala Setar
Sarawak	Lundu, Serian, Sibuti, Kanowit
Sabah	Kota Belud, Papar, Tenom, Sandakan

Table 2. Distribution of *Mangifera* species in various states

Species	Johor	Kelantan	Pahang	Negeri Sembilan	Perak	Kedah	Melaka	Selangor	Terengganu	Sabah	Sarawak	Total
M. quadrifida		*			*				*	*	*	5
M. foetida	*	*	*	*	*	*	*	*	*	*	*	11
M. pajang										*	*	2
M. caesia	*	*	*	*	*	*	*	*	*	*	*	11
M. torquenda											*	1
M. odorata	*	*	*	*	*	*	*	*	*	*	*	11
M. lagenifera	*		*	*			*					4
M. indica	*	*	*	*	*	*	*	*	*	*	*	11
M. laurina					*			*	*	*	*	5
M. pentandra	*	*	*		*	*		*	*	*	*	9
M. griffithii	*		*		*	*			*		*	6
M. microphylla											*	1
M. kemanga	*											1
M. longipetiolata				*								1
Total	8	6	7	6	8	6	5	6	8	8	11	79

during land development. *Mangifera* species enumerated in home gardens or orchards ranged from 1–5 with a mean of two species per garden (*Table 3*).

About 88% of the home gardens in Sabah maintained *Mangifera* species while those in Kelantan only 30%. Sarawak had the highest species richness, S = 11, accounted for 79% of the observed diversity (*Figure 1* and *Table 4*). Melaka showed the least number of *Mangifera* species (S = 5, 36%). Other states which had a relatively high species richness were Johor, Perak, Terengganu and Sabah where S = 8 (57%). Although Sarawak has the highest species richness, the species diversity is low as revealed by the Shannon Diversity Index (H' = 0.484), which is contributed by the uneven distribution of the species. Johor, however, showed the highest species diversity H' = 1.649, followed by Sabah H' = 1.592, Selangor H' = 1.453, Terengganu H' = 1.305 and Pahang H' = 1.252 (*Table 4*).

Among the *Mangifera* species, four species *M. indica, M. odorata, M. foetida* and *M. caesia* were common and widespread, being cultivated in all the 11 states throughout the country (*Figure 2* and *Table 2*) and hence they do not appear to be threatened species, although varietal diversity (genetic diversity) needs to be checked for developing conservation strategy. In Peninsular Malaysia, *M. caesia* is known to be domesticated and popular in Melaka and Terengganu. However, most of the trees were old, being cultivated at least for the last two generations. An effort to plant new *M. caesia* trees was carried out by only very few farmers in Peninsular Malaysia and as such the threat of genetic erosion is high.

Unlike in Peninsular Malaysia, surprisingly, *M. caesia* (binjai) or locally known as *Beluno* is being extensively cultivated in Sabah. Binjai fruits from Sabah normally has superior taste than those from Peninsular Malaysia (Salma 2009) which could be due to the difference in the genotype. Besides, Sabah also showed the highest diversity in kuini, followed by Terengganu and Melaka (*Table 2*). Although *M. pentandra* was found in the home gardens in nine states except Negeri Sembilan and Melaka, this is actually not a true scenario. The distribution of *M. pentandra* is rather scarce but its occurrence was noticed in other home gardens that were not surveyed in these two states (*Figure 2*).

Mangifera pajang is endemic to Sabah and Sarawak and it is found frequently in home gardens in these two states and its status is low risk (*Table 2*).

Table 3. Range and mean of *Mangifera* species and percentage of home gardens maintaining *Mangifera* species

State	Range and mean of *Mangifera* spp./HG	No. of home gardens possessed *Mangifera* spp. (%)
Selangor	(1–2) 1	54
Melaka	(1–3) 2	84
Kedah	(1–2) 2	45
Perak	(1–3) 2	54
Pahang	(1–4) 2	35
Kelantan	(1–3) 2	30
Johor	(1–2) 2	35
Terengganu	(1–4) 2	58
Negeri Sembilan	(1–4) 1	50
Sabah	(1–5) 3	88
Sarawak	(1–4) 2	77

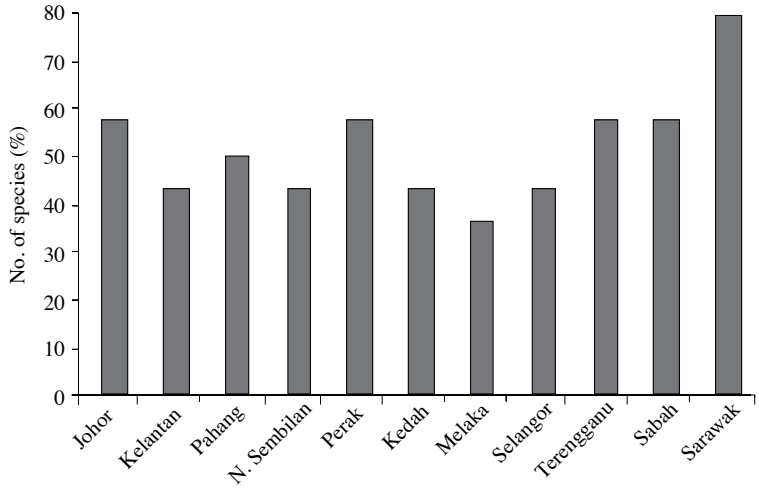

Figure 1. ***Mangifera*** *species in different states (as % of total number of species found in the survey)*

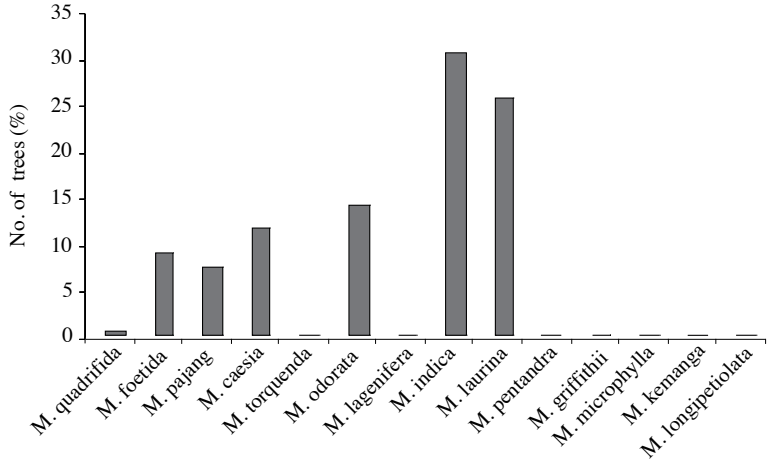

Figure 2. ***Mangifera*** *trees as percentage of total trees recorded*

Table 4. Shannon Diversity Index, evenness and richness

States	Shannon Index H'	Evenness E	Species richness S
Kelantan	0.800	0.446	6
Terengganu	1.305	0.628	8
Johor	1.649	0.793	8
Perak	1.115	0.536	8
N. Sembilan	1.132	0.632	6
Pahang	1.252	0.643	7
Melaka	1.321	0.821	5
Selangor	1.453	0.811	6
Kedah	1.277	0.713	6
Sabah	1.592	0.765	8
Sarawak	0.484	0.202	11

Based on the occurrence of the number of individuals of a species as well as their distribution, six species could be considered as very rare or threatened (*Figures 1–2* and *Table 2*). These species normally occur as a single individual formerly grown by ancestors of current owners or left uncut during land clearing for developing an orchard or building houses. These are *M. longipetiolata* (sepam) (0.004%), *M. torquenda* (kemantan) (0.015%), *M. microphylla* (raba) (0.011%), *M. griffithii* (rawa) (0.174%), *M. kemanga* (kemang) (0.019) and *M. lagenifera* (lanjut) (0.022%) (*Figures 1–2*). These species are becoming unpopular because of their inferior fruit quality and as such there is neither interest in maintaining them nor growing in new plantings.

These very rare species require immediate action by collecting and planting them in the field genebank as *ex situ* conservation which could be useful genetic resource for crop improvement for the present and also for the future. In addition, it may be very useful to check the protected forests for occurrence of these six species so that they can be conserved in *in situ* as well.

Conclusion and recommendation

Home gardens or orchards harbour a significant number of *Mangifera* species. *Mangifera longipetiolata, M. torquenda, M. microphylla, M. griffithii, M. kemanga* and *M. lagenifera* are considered as threatened since there are no new plantings and the plants are very old. The genotypic variation however exists within the common *Mangifera* species, *M. indica, M. odorata, M. caesia* and *M. laurina* which serve as new genetic resources. The variability of the wild relatives provides useful genetic resources for on-farm conservation.

A concerted sampling strategy, especially for the very rare species, should be enhanced for *ex situ* conservation in order to meet urgent needs for crop improvement research. Recommendation for the establishment of sites for effective on-farm as well as *in situ* conservation of *Mangifera* species should also be considered.

The other *Mangifera* species which are not found in cultivation are probably available in the forest. Their status and occurrence should be determined and mapped and should also be collected for *ex situ* conservation.

Acknowledgement

The authors would like to thank Mr Mohd. Nor Awaluddin for technical assistance. Sincere thanks are also due to the Directors and the staffs of the Department of Agriculture Peninsular Malaysia, DOA Sarawak and DOA Sabah for their help during the survey.

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Abstrak

Survei terhadap spesies *Mangifera* telah dijalankan di 25 kawasan rumah atau dusun bagi setiap 25 daerah dalam 11 negeri di negara ini. Sejumlah 14 spesies *Mangifera* didapati ditanam di kawasan halaman rumah atau dusun. Setiap halaman rumah mempunyai 1–5 spesies *Mangifera*. Negeri Sarawak mempunyai jumlah spesies yang tertinggi S = 11, iaitu 79% daripada jumlah diversiti yang diperhatikan. Tetapi kepelbagaian spesies didapati rendah (Shannon Diversity Index H' = 0.484) disebabkan oleh taburan spesies yang tidak seragam. Johor menunjukkan kepelbagaian spesies yang tertinggi H' = 1.649, diikuti oleh Sabah H' = 1.592, Selangor H' = 1.453, Terengganu H' = 1.305 dan Pahang H' = 1.252. Empat spesies *Mangifera* iaitu *M. indica, M. odorata, M. foetida* dan *M. caesia* ditanam di semua negeri di seluruh negara. *Mangifera pajang* (bambangan) didapati endemik di Sarawak dan Sabah. Spesies *Mangifera* yang dianggap sebagai sangat nadir atau terancam disebabkan hanya terdapat di beberapa kawasan dengan bilangan yang amat kecil ialah *M. longipetiolata* (sepam) (0.004%), *M. torquenda* (kemantan) (0.015%), *M. microphylla* (raba) (0.011%), *M. griffithii* (rawa) (0.174%), *M. kemanga* (kemang) (0.019%) dan *M. lagenifera* (lanjut) (0.022%). *Mangifera torquenda* dan *M. microphylla* hanya dijumpai di Sarawak sahaja.

Appendix 1. Other important rare fruit species surveyed

Scientific names	Common names
*Artocarpus elastic*us	Terap
Artocarpus integer	Cempedak
Baccaurea macrocarpa	Tampoi
Baccaurea motleyana	Rambai
Dimocarpus longan subsp. *Malesianus*	Mata kucing
Durio kutejensis	Durian nyekak
Garcinia cowa	Kandis
Garcinia mangostana	Manggis
Lansium domesticum	Langsat
Nephelium cuspidatum var. *robustum*	Rambutan gergasi
Nephelium maingayi	Redan
Nephelium maingayi	Serait
Nephelium ramboutan-ake	Pulasan
Parkia speciosa	Petai
Pithecellobium jiringa	Jering

Accepted for publication on 28 September 2009