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Use Values and Cultural Importance of Major Tropical Fruit Trees: An Analysis from 24 Village Sites Across South and South-East Asia

Vasudeva R[1*], Bhuwon Sthapit[2], I Salma[3], Suchitra Changtragoon[4], Idha W Arsanti[5], D Gerten[6], Nataya Dum-ampai[7], S Rajan[8], MR Dinesh[9], IP Singh[10], Sanjay Kumar Singh[11], BMC Reddy[12], VA Parthasarathy[12] and V Ramanatha Rao[13]

[1]*Department of Forest Biology and Tree Improvement, College of Forestry, Sirsi-581401, University of Agricultural Sciences, Dharwad-580005, Karnataka, India*
[2]*Bioversity International, Bioversity-Nepal Office, 93.4 Dharahara, Pokhara, Nepal*
[3]*Malaysian Agricultural Research and Development Institute, Persiaran MARDI-UPM, 43400 Serdang, Selangor, Malaysia*
[4]*Forest & Plant Conservation Research Office, Department of National Park Wildlife & Plant Conservation, 10900 Chatuchak, Bangkok, Thailand*
[5]*Indonesian Centre for Horticulture, Research and Development, Jalan Ragunan 19, Pasar Minggu-12520, Jakarta, Indonesia*
[6]*Malaysian Agricultural Research and Development Institute, No. 95, Lot 7316, Medan Sentral Commercial Centre, Kidurong Road, 97000 Bintulu, Sarawak, Malaysia*
[7]*Chiangmai Royal Agricultural Research Centre, Hangdong District 50230, Chiangmai, Thailand*
[8]*ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow-227107, Uttar Pradesh, India*
[9]*ICAR-Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bengaluru-560089, Karnataka, India*
[10]*ICAR-National Research Centre for Citrus, Nagpur-440010, Maharashtra, India*
[11]*ICAR-National Research Centre for Litchi, Muzaffarpur-842002, Bihar, India*
[12]*ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru-560089, Karnataka, India*
[13]*Bioversity International, Rome, Italy*

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Native communities of South and South East Asia, a centre of diversity of tropical fruit trees (TFT), share a common cultural heritage associated with tropical fruits. Unfortunately, there is a dramatic loss of traditional knowledge associated with TFTs. This comparative study was undertaken in 24 village communities spread across India, Indonesia, Malaysia and Thailand using structured questionnaires and multiple approaches to document use-value of TFTs. Considering only four focal genera of TFT species *viz*., *Mangifera*, *Garcinia*, *Citrus* and *Nephelium*, an amazing diversity of 56 species was reported to be utilized by the communities. Ranking of species based on the number of use-categories and based on the cultural importance value showed differences. *Mangifera indica*, *Citrus aurantifolia* and *C. reticulata* were the three extensively used TFTs as food and for processing. As revealed by Jaccards' index, three South East Asian countries showed a higher similarity among themselves than India. *M. indica*, *M. pajang*, *M. foetida*, *G. morella*, *G. atroviridis*, *G. mangostana*, *C. hystrix*, *C. aurantifolia* and *C. grandis* were culturally the most significant TFTs and hence may be conserved with high priority.

Key Words: Tropical fruit trees, Use value, Cultural significance, South and South-East Asia

Introduction

Fruit trees are important components of stable agro-ecosystems and provide valuable resources as well as broad range of forest products in the form of food supplements to the rural communities (Ramanatha Rao and Bhagmal, 2002). Environmental services provided by fruit trees such as protecting and, providing habitats for pollinators, and storing carbon are valued in the tens of billions of dollars annually. Fruit trees provide important adaptive values and tend to be more resilient to climate change due to their perennial nature (Sthapit *et al*., 2012). Hence diverse native fruit trees are used by farming communities to improve nutrition in their food and augment the farm ecology, hence farmers also hold valuable information on the diversity and its uses. World over, there is a renewed interest in documenting the use values of fruit trees. Use of tropical fruit species is a part of the Traditional Knowledge (TK), which is a rational and reliable knowledge developed through generations of intimate contact with the nature by the local people

**Author for Correspondence: E-mail: vasudevar@uasd.in; vasukoppa@gmail.com*

(Mauro and Hardison, 2000). Knowledge about the identification and use of tropical fruits is an integral part of the local food tradition and indigenous knowledge systems and practices that have been developed over many generations (Vinceti *et al*., 2013). The TK is generally associated with biological resources and is invariably an intangible component of such a biological resource. However, there is a dramatic loss of traditional knowledge associated with tropical fruits. Key to the conservation of tropical fruit resources and of the associated TK is the scientific documentation of knowledge relating to their uses and assessing the cultural significance. Based on the role that species plays as food, shelter, medicine, *etc*. in a specific culture, its cultural significance is assessed (Pieroni, 2001). Native communities of South and South-East Asia share a common cultural heritage of use of tropical fruits for diversified purposes and their associated traditional knowledge. Use of native tropical fruits is perhaps most conservative aspect of any culture but highly vulnerable to loss. However there is a paucity of a comparative study of use values of tropical fruit trees across this region. With this background, the study was aimed at the following: (a) document local specific uses of four focal genera of tropical fruit trees *viz*., *Mangifera*, *Garcinia*, *Nephelium* and *Citrus* in 24 village sites, set in diverse agro ecosystems in four nations of South and South-east Asia; (b) to compare the cultural significance of the use values of focal species in these countries and (c) to understand the cultural significance and abundance of these species. Here, we report the salient results of a larger study under the UNEP/GEF-supported regional project titled "Conservation and sustainable use of cultivated and wild tropical fruit diversity: promoting sustainable livelihoods, food security and ecosystem services", implemented in India, Indonesia, Malaysia and Thailand.

Materials and Methods

Tropical fruit tree (TFT) species occurring around 24 village sites in India, Indonesia, Malaysia and Thailand were studied with an objective of documenting their local uses and assessing their cultural importance (CI) value under the UNEP/GEF-supported regional project. The geographic details, agro-ecosystems and general features of each site are provided in Table 1. The landscapes included a mosaic of agricultural land, tree plantations, tree gardens, meadows, and forests. All 24 sites were biologically rich areas comprising of focal TFT species. In India, study sites consisted of home gardens, commercial, semi-commercial orchards, set in agricultural ecosystems and forest ecosystems. The eight sites of Indonesia consisted of home gardens, commercial, semi-commercial orchards located in agricultural ecosystems, forest ecosystems, and island ecosystems. The sites of Malaysia were located in hilly zones, along the coast which consisted of orchards as the major production systems. In Thailand, sites were consisted of multi-species orchards, home gardens in low lands, river bank that flood annually (Table 1).

Over a period of five years, multiple sources of information such as participatory rural appraisals, baseline surveys, focal group discussion on TK documentation, fruit diversity fairs, community fruit catalogues and key informant surveys of custodian farmers were used to document the locally specific uses of four focal genera *viz*., *Mangifera*, *Garcinia*, *Nephelium* and *Citrus*. Information was obtained from the respondents through personal interviews and field observations through structured questionnaires prepared for the purpose, following a prior informed consent. For the purpose of this study the data on uses were grouped into 14 use-categories based on folk perceptions such as consumption, processing as food, use as medicine, use as cosmetic, use as bio-pesticide, use as timber, *etc*. A short description of each of the use-category is provided in Table 2.

The identified respondents in each village (about 20 to 50 households in each community) were interviewed personally to collect data related to aspects as detailed in research questionnaires. The individual household survey involved questions on tropical fruit species diversity, their frequency, use and marketing aspects. In home-gardens, the number of tropical fruit tree species, their frequency and density, varieties, average tree age, economic parts of the tree species, consumption patterns, area under fruit tree cultivation and total landholding size were recorded.

To estimate the cultural significance of each species, CI value was computed, which was introduced by Philips and Gentry (1993) and adopted by Pardo-de-Santayana *et al.* (2007). This index measures the use-value of a plant by including the number of informants citing a given use-value. It was computed using the following formula:

$$CI = \sum_{i=1}^{i=NU} \frac{URi}{N}$$

Table 1. Localities, number of households visited, agro-ecosystems and general features across four countries

S. No.	Country/ province (State)	Localities/ site names	Agro-eco system/forest types	General features
1	India, Uttar Pradesh	Malihabad	Orchards	Commercial oriented mango belt with high intra specific diversity and old orchards with seedling types.
2	India, Bihar	Pusa	Orchards, Home gardens	Semi-commercial with some old orchards with seedling types, potential to strengthen home gardening
3	India, Maharashtra	Amravati	Orchards	Commercial oriented citrus belt with active farmer association and nurseries. Mango seedling types exist; Unique area as citrus trees flowers twice a year
4	India, Karnataka	Sirsi	Orchards, Home gardens, Forest Ecosystem	Forested area including collection from wild to semi commercial gardens
5	India, Andhra Pradesh	Chittoor	Orchards	Commercial mango orchards with variety diversity
6	Indonesia, East Java	Kediri	Home gardens, Orchards	Semi-commercial area with high inter specific diversity in home gardens, some orchards and a communal forest ecosystem
7	Indonesia, East Java	Magetan	Orchards, Home gardens	Commercial oriented area with citrus orchards and home garden
8	Indonesia, South Kalimantan	Telaga Langsat	Forests, Home gardens	Located in the hills with trees found in home garden, along paddy field and in community forest
9	Indonesia, South Kalimantan	Pembantanan	Along paddy fields	Low wetland and trees mostly found along paddy fields
10	Indonesia, South Kalimantan	Sungai Kambat	Orchards	Low wetland area, commercial oriented with active farmer groups
11	Indonesia, South Kalimantan	Sungai Tuan Hilir	Orchards	Low wetland area, semi-commercial oriented
12	Indonesia West Sumantra	Kampung Dalan	Forested community	Community forests with buffer zones
13	Indonesia West Sumantra	Latang	Forested community	Community forests with buffer zones
14	Malaysia, Sabah	Kota Belud	Home gardens	Home gardens mainly producing for home consumption located at the foot of the hills
15	Malaysia, Sabah	Papar	Home gardens	Traditional home garden system with high inter species diversity for semi-commercial use in low lands
16	Malaysia, Sarawak, Miri	Sibuti	Home gardens	Home gardens and fields in the hills close to the coast line
17	Malaysia, Sarawak, Kuching	Serian	Forest	Community forest system in lower mountains, mainly for home consumption
18	Malaysia, Peninsular, Kedah	Yan	Orchards	Semi-commercial orchards along the coast line
19	Malaysia, Peninsular, Perak	Bukit Gantang	Home gardens	Semi-commercial home gardens with active/responsive community
20	Thailand	Huaithaptha, Srisaket	Home gardens, Community forests	Multi species, low land home gardens producing the TFTs Natural habitat along the river bank, annually flooded
21	Thailand	Trok Nong Chantaburi	Home Gardens, Orchards	Home gardens with intercropping. Mangosteen, Durian are mainly grown in the coastal region
22	Thailand	Banmae -o- nai Chiang Mai	Home Gardens, Orchards	Home gardens produce TFTs for the household purposes. Multi-varietal commercial orchards for Mango and Litchi in the hill side region
23	Thailand	Nhongtrea	Home gardens	Home gardens with multi-species TFTs producing TFTs at the foot-hill
24	Thailand	Kiriwong Nakorn, Srithammar	Home Gardens, Orchards	Home gardens with multi species trees on the mountain terrain

TFTs = Tropical fruit trees

where 'N' is the number of sites (number of sites within a country where the species is reported), 'NU' is the number of different use-categories and 'UR' is the number of different uses mentioned by site *i*. When all the sites cite a specific use, the ratio UR/N would be 1. The upper value of the CI is equal to the total number of use-categories (15).The CI value was computed for each country separately. This additive index takes into

Table 2. Use-categories and their short description

Use-category	Description
Aesthetic value	Any part used for decoration of self/homes/temples/ambience/ landscape
Bio pesticide	Used to control the insects and diseases of plants
Consumption	Fruit/leaf/root/stem parts are eaten raw/routinely cooked
Cosmetic use	Any part used for cosmetic purposes
Fodder	Leaves used as fodder
Handicraft	Handicrafts are made from any part
Medicine	Any part used as medicine/local health care
Mulch	Used for soil cover
Processing	Any part processed as juice/jam/pickle/pappad/sauce/wine *etc.*
Timber/small timber	Used for house-hold timber purposes
Soil Protection	Planted to protect the soil
Used in ritual	Any part used in ritual/festival/offered to Gods/spirits
Used for dye	Any part used to extract the dye
Wind break	Planted as wind break
Other uses	Any other major category such as root stock/butter extraction etc.

account the spread of use (number of sites) for each species and number of uses. The theoretical maximum value of the index is the total number of different edible use-categories. Culturally most significant species were identified as those with top ten ranks. The similarity between two countries was computed using Jaccards' index.

Results and Discussion

South and South East Asia has been recognized as a centre of diversity of tropical fruits and boasts of over 500 TFT species. Because of varying agro-ecological conditions and varying cultural milieu of the communities, a large array of intra specific variation has been accumulated among the TFTs. These variations have been efficiently recognized and used by the local communities. However, this knowledge associated with TFTs is highly vulnerable for loss than the TFTs resource *per se*. Hence there is a need for the documentation of the locally specific uses and to assess the cultural significance objectively. Evaluation of various uses of tropical fruits across a regional level considering different cultural contexts is important to compare intercultural variations/similarities in resource use. Such comparisons would ultimately lead to the insights on prioritizing the species for conservation and in developing new drugs/food additives, *etc*.

In this study, considering only four focal genera of the TFT species *viz*., *Mangifera, Garcinia*, *Citrus* and *Nephelium*, an amazing diversity of 56 species were reported to be utilized by the communities (Table 3). Among the four countries, highest numbers of 26 species were used by the communities in Indonesia and Thailand, while those of Malaysia and India were dependent on 18 species and 17 species, respectively (Table 3). At a regional scale, communities dependent on the genus *Citrus* to a great extent with 20 species and then on genus *Garcinia* (17). The focal tropical fruits were used in a variety of uses that ranged from simple eating raw fruit, to be used as bio-pesticide and used in religious rituals. A complete list of specific uses of the species is appended as annexure I. Very interesting uses of TFTs have been documented. The sticks of *G. fusca* (Madan) in Thailand, are used to grill chicken for special culinary preparation that imparts a well-liked flavour. Young leaves of the same species are used as additives in many Thai dishes. The bark of *M. pentandra* is used in Malaysia to boost men's virility; while the fruits of *G. forbesii* are used in birth control.

Table 3. Total number of species of four tropical fruit tree genus found to be used by the communities in different countries

Country	*Mangifera*	*Garcinia*	*Citrus*	*Nephelium*	Total
India	1(1)	3(3)	13(6)	0(0)	17
Indonesia	12(4)	4(3)	8(2)	2(0)	26
Malaysia	9(4)	4(3)	3(1)	2(2)	18
Thailand	7(7)	8(2)	10(1)	0	26
Overall number of species*	15	17	20	4	56

Values in the parentheses indicate the number of culturally important species as determined by the top ten ranks of the CI value
*not a simple column total, since there are overlapping occurrence of species among the countries

In Sabah, Sarawak and South Kalimantan, fruits of *M. odorata* and *M caesia* are used for fresh consumption, while *M. pajang* (Bambangan) is mainly processed into pickle alone or with fish. In the Western Ghats of India, acrid sap from young fruits of aromatic pickle mango (*appemidi*) varieties are collected and preserved to be used to spice-up several dishes. Various types of aroma ranging from cumin to camphor are identified by the communities and used in different dishes. The wood of *G. speciosa* is used for making handle of agricultural implements and for hoe, knife, and sticks for fencing in Thailand. The tree resinous exudates of several species of *Garcinia* are used in fabric colouring in India, Indonesia and Thailand. Surprisingly, several species of *Citrus* are associated with rituals/black magic in every country while mango is associated with other religious purposes, suggesting that non-biological factors are also important in computing the cultural significance of a species.

Cultural Importance (CI) Value of Tropical Fruits Across Different Countries

Ranking of species based on the number of use-categories and based on the CI value showed differences. Since CI is more robust in truly assessing the significance, more emphasis could be placed on this.

In India, mango showed highest number of uses and cultural importance value suggesting its deep cultural value. *G. morella* and *C. limon* were next best in terms of CI (Table 4). Further, all the other species of the four target genera also showed relatively high values of CI. These major TFT genetic resources are part and parcel of the home-gardens and farmland suggesting the domestication of these valuable TFT genetic resources for household consumption from the growers. This is because farmers tend to domesticate only those local varieties that are most likely to satisfy their specific needs and preferences.

Communities of Indonesia valued *C. hystrix* and *C. grandis* higher over all other species (Table 5). These two species were on the top both with respect to the number of uses as well as with CI. *G. atroviridis* was also reported to be having a higher use value and CI value. *M. indica* and *M. odorata* were next best in terms of CI. All most every species reported had relatively high values of CI.

In Malaysia, considering the number of use-categories, *G. mangostana* ranked first, however, the CI value revealed that *M. pajang* was at the top (Table 6). The top ranking of species based on the two measures were different. Interestingly *G. atroviridis* with only two reported use-categories ranked second in terms of CI values. Geographically, the top two species with the highest value of CI in Malaysia were distantly located from each other; with *M. pajang* was endemic to East Malaysia region, in the Borneo Island while *G. atroviridis* can only be found in Peninsular Malaysia. This showed that both species were culturally important to different communities of different region.

Communities of Thailand valued *G. mangostana* the most as revealed by both number of use-categories and CI value. *C.hystrix, C. aurantifolia* and *M. foetida* were also in the top ranking category (Table 7).

Culturally Most Significant Species Across Different Countries

There were substantial differences among the uses of species across the four countries suggesting differences in the cultural base. *M. indica, C. aurantifolia* and *C. reticulata* were extensively used as food and used for processing and were culturally significant species in all the four countries. Perhaps wide spread commercial interest along with cultural importance could be the reason for the same. *C. medica* (as the name implies) was reported to be used for medicinal purposes and was a culturally significant species in all the countries except Malaysia. Among the three South East Asian countries, *G. atroviridis* and the genus *Citrus* were common suggesting a shared cultural thread. As revealed by Jaccards' index, there was a higher similarity of communities of India with that of Thailand and least with Malaysia (Table 8). The three South East Asian countries showed a higher similarity among themselves perhaps because India is geographically isolated from these three nations.

In India, only one species of mango, *M. indica*, and all the three species of *Garcinia* reported by the communities were within the top 10 ranks and hence were designated as culturally most significant. In Indonesia, four out of 12 reported species of *Mangifera*, three species of *Garcinia* out of four, two species of *Citrus* out of eight reported were culturally most significant. In Malaysia, nearly half of the species belonging to *Mangifera* and about 75% of the species of *Garcinia* and both the species of *Nephelium* were culturally highly significant. The communities of Thailand reported that the genus *Mangifera* which had the largest number (n=7) of species as culturally the most significant (Fig.1). In general,

Table 4. Comparative list of ranks of species according to the number of use categories reported and cultural value index computed for five sites of India

Rank	Species	Number of use categories	Species	Cultural importance value
1	*Mangifera indica*	9	*M. indica*	7.20
2	*Citrus aurantifolia*	7	*G. morella*	5.00
3	*Garcinia gummi-gutta*	6	*C. limon*	4.60
4	*G. indica*	6	*C. aurantifolia*	4.00
5	*G. morella*	6	*G. gummi-gutta*	4.00
6	*C. limon*	5	*G. indica*	4.00
7	*C. medica*	4	*C. medica*	3.25
8	*C. grandis*	3	*C. sinensis*	3.00
9	*C. maxima*	3	*C. reticulata*	2.50
10	*C. reticulata*	3	*Citrus sp.*	2.00
11	*C. sinensis*	3	*C. decumana*	2.00
12	*C. aurantium*	2	*C. maxima*	1.75
13	*C. decumana*	2	*C. grandis*	1.25
14	*Citrus* sp.	2	*C. jambhiri*	1.00
15	*C. jambhiri*	1	*C. pseudolimon*	1.00
16	*C. pseudolimon*	1	*C. reshni*	1.00
17	*C. reshni*	1	*C. aurantium*	0.75

Table 5. Comparative list of ranks of species according to the number of use categories reported and cultural value index computed for eight sites of Indonesia

Rank	Species	Number of use categories	Species	Cultural value index
1	*Citrus hystrix*	9	*C. hystrix*	8.00
2	*C. grandis*	8	*C. grandis*	7.00
3	*C. limonia*	8	*G. atroviridis*	7.00
4	*Garcinia atroviridis*	8	*M. indica*	7.00
5	*C. microcarpa*	7	*M. odarata*	6.50
6	*C. reticulata*	7	*G. griffithii*	6.00
7	*C. sinensis*	7	*Garcinia sp.*	6.00
8	*G. griffithii*	7	*G. xanthochymus*	6.00
9	*Garcinia sp.*	7	*M. applanata*	6.00
10	*Mangifera casturi*	7	*M. casturi*	6.00
11	*M. griffithii*	7	*M. griffithii*	6.00
12	*M. indica*	7	*M. laurina*	6.00
13	*M. odarata*	7	*M. torquenda*	6.00
14	*C. aurantifolia*	6	*Nephelium* spp.	6.00
15	*G. xanthochymus*	6	*C. reticulata*	5.67
16	*M. applanata*	6	*C. sinensis*	5.67
17	*M. torquenda*	6	*C. microcarpa*	5.50
18	*Nephelium* sp.	6	*M. pentandra*	5.00
19	*C. medica*	5	*N. maingayi*	5.00
20	*M. laurina*	5	*C. aurantifolia*	4.67
21	*M. rufocostata*	5	*M. rufocostata*	4.50
22	*N. maingayi*	5	*C. medica*	4.00
23	*M. foetida*	4	*M. havilandii*	4.00
24	*M. havilandii*	4	*C. limonia*	4.00
25	*M. caesia*	3	*M. caesia*	3.00
26	*M. pentandra*	3	*M. foetida*	3.00

species yielding edible fruits are generally valued high by the communities. For instance, Manuel *et al*. (2007) has shown that all the domesticated and wild edible fruit species in six regions of Spain and Portugal were in the top 10 places. Further, there could be a strong association of cultural importance value and the frequency of TFTs in a community. In a recent study, Hegde (2014) has shown positive correlation between the CI value of a species and the log frequency of the TFT species in the two village sites of the Western Ghats of India. However, Pieroni (2001) has shown that wild greens were more valued in Italy than the wild fruits hence other factors

Table 6. Comparative list of ranks of species according to the number of use categories reported and cultural value index computed for six sites of Malaysia

Rank	Species	Number of use-categories	Species	Cultural value index
1	*Garcinia mangostana*	6	*M. pajang*	4.25
2	*Nephelium lappaceum*	5	*G. atroviridis*	3.50
3	*G. parvifolia*	4	*M. caesia*	3.25
4	*M. caesia*	4	*N. lappaceum*	3.20
5	*M. pajang*	4	*G. mangostana*	3.17
6	*M. pentandra*	4	*C. aurantifolia*	3.00
7	*G. forbesii*	3	*Mangifera* sp.	3.00
8	*M. indica*	3	*N. ramboutan-ake*	3.00
9	*M. odorata*	3	*G. forbesii*	2.67
10	*M. quadrifida*	3	*M. pentandra*	2.25
11	*Citurs aurantifolia*	2	*M. griffithii*	2.00
12	*G. atroviridis*	2	*G. parvifolia*	1.75
13	*N. ramboutan-ake*	2	*M. odorata*	1.67
14	*C. microcarpa*	1	*M. indica*	1.33
15	*Citrus* sp.	1	*C. microcarpa*	1.00
16	*M. griffithii*	1	*Citrus* sp.	1.00
17	*M. laurina*	1	*M. laurina*	1.00
18	*Mangifera* sp.	1	*M, quadrifida*	1.00

Table 7. Comparative list of ranks of species according to the number of use categories reported and cultural value index computed for five sites of Thailand

Rank	Species	Number of use-categories	Species	Cultural value index
1	*Garcinia mangostana*	7	*G. mangostana*	5.25
2	*Citrus hystrix*	5	*M. duperreana*	5.00
3	*Mangifera foetida*	5	*M. foetida*	4.00
4	*M. indica*	5	*C. aurantifolia*	4.00
5	*C. aurantifolia*	4	*Garcinia sp.(Son kandari)*	4.00
6	*G. atroviridis*	4	*M. cochinchinensis*	4.00
7	*Garcinia* sp. (Son kandari)	4	*M. hypoleucum*	4.00
8	*M. cochinchinensis*	4	*M. lagnifera*	4.00
9	*M. duperreana*	4	*M. odorata*	4.00
10	*M. hypoleucum*	4	*M. indica*	3.60
11	*M. lagnifera*	4	*G. atroviridis*	3.50
12	*M. odorata*	4	*C. hystrix*	3.40
13	*C. maxima*	3	*N. lappaceum*	2.70
14	*G. speciosa*	3	*C. maxima*	2.50
15	*N. lappaceum*	3	*G. speciosa*	2.25
16	*C. aurantium*	2	*C. aurantium*	2.00
17	*C. medica*	2	*C. medica*	2.00
18	*C. reticulata*	2	*C. reticulata*	2.00
19	*C. madurensis*	2	*C. madurensis*	2.00
20	*G. cowa*	2	*G. cowa*	2.00
21	*G. hanburyi*	2	*G. hanburyi*	2.00
22	*G. schomburgkiana*	2	*G. schomburgkiana*	2.00
23	*G. fusca* (Madan)	2	*G. fusca* (Madan)	2.00
24	*Citrus* sp. (Junkra)	1	*Citrus* sp. (Junkra)	1.00
25	*Citrus* sp. (Makrud)	1	*Citrus* sp. (Makrud)	1.00
26	*Citrus* sp. (Somjangkra)	1	*Citrus* sp. (Somjangkra)	1.00

such as availability, multi functionality, medicinal and/or ritual characteristics may contribute to the importance of a species.

Thus in summary, this study identifies *M. indica, M. pajang, M. foetida, G. morella, G. atroviridis, G. mangostana, C. hystrix, C. aurantifolia* and *C. grandis* as culturally the most significant and hence deserve higher priority in efforts to conserve TFT genetic resources. Culturally most significant species identified in the current study through CI values across South and South East Asia need to be focused for conservation and utilization. Many authors have reported the same view

Table 8. Similarity among tropical fruit species of focal genera among four countries as revealed by the Jaccards' index expressed (%)

Country	Indonesia	Malaysia	Thailand
India	9.0	5.0	15.0
Indonesia		21.0	14.0
Malaysia			13.0

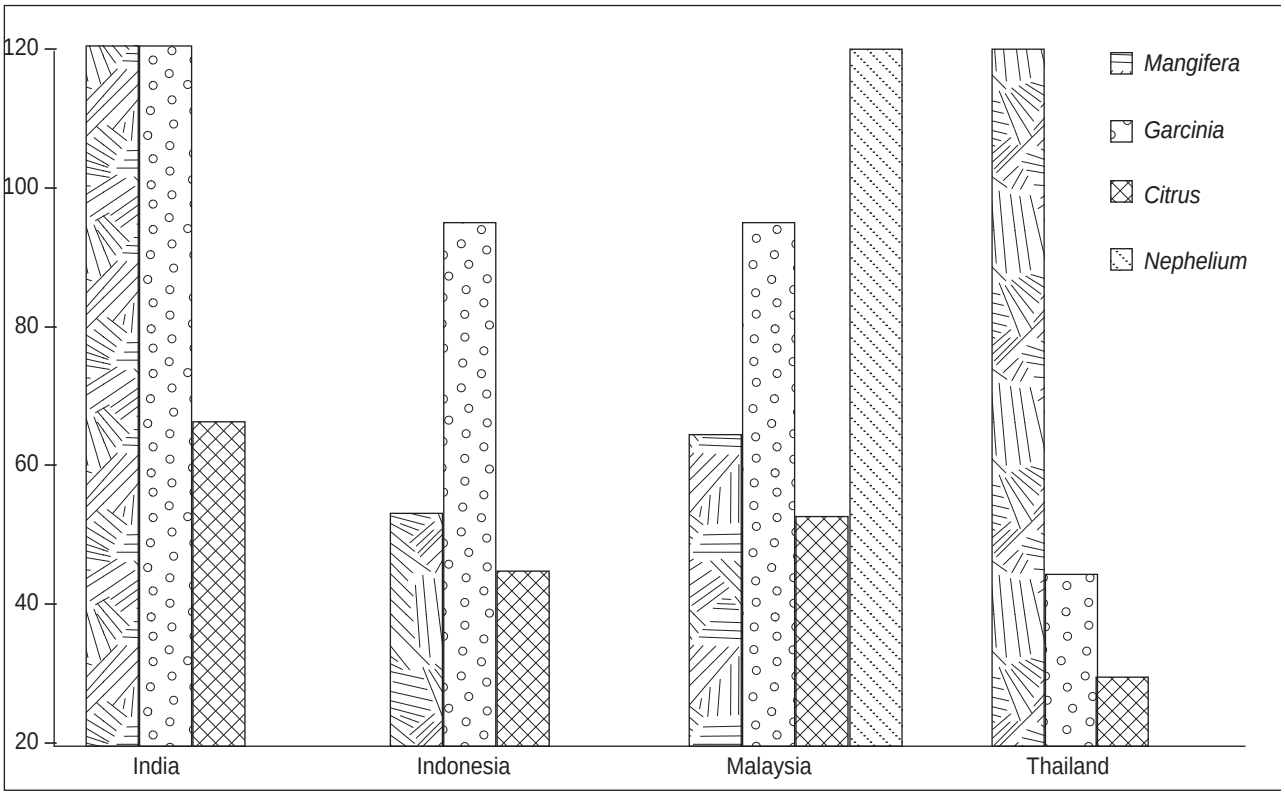

Fig. 1. Per cent species of four important genera of tropical fruit trees that are culturally most significant in India, Indonesia, Malaysia and Thailand

earlier (Dawson *et al*., 2011; Leakey and Ajayi, 2007; Sthapit *et al*., 2007; Gavali and Sharma, 2004). This analysis also provides a good starting point for further inter-cultural comparisons using multivariate analyses.

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Appendix I

A. List of uses of different species of focal TFT, recorded in study sites of India

Species	Uses
Mangifera indica	Leaves used in folk festivals Timber is useful for making traditional boats Ripe fruits edible Raw fruits used in making traditional dishes like *chutney, Tambuli* etc. Pulp of the fruit used in making jams, syrups, leather*etc*. A traditional dish '*Mamla'* prepared by drying pulps Tender fruits of special Mango variety (*Appe*) made into pickles Raw fruits made into cut pickles The resin from the tender mango of special variety are collected and stored and it is used as a flavouring agent for special soup called '*Appehuli'*
Garcinia gummi-gutta	Dried rind used as souring material for fish and other non-vegetarian curries Gamboge a gum resin is obtained from the peeled bark used as colouring pigment Butter or oil extracted from seeds used in making confectionary items Unripe fruit rind is pickled Ripen fruit rind used in cleaning utensils, gold and silver fruit pulp used as medicine to cure acid reflux
G. indica	Ripe fruit is eaten raw Pulp and rind used in making summer refreshing drink (*Kokum*) Pulp and rind used in making traditional soups (*Tambuli, Solkadi*) Rind used as condiments instead of tamarind Rind powder used in making soft drinks soups Butter extracted from seeds used in making culinary items Butter used as ointments as lip guards Butter used as medicine for gastrointestinal disorder Rind and pulp used for acidity
G. morella	Colouring pigments obtained from seed coats used in painting traditional arts and also for painting house walls Butter extracted from seeds employed in local medicines and also for making traditional dishes
Citrus aurantifolia	fruit juice used in making soft drinks (*Sherbat*) fruits used for pickling and lime chutney fruit juice used in cleaning products essential oil extracted from rind used for making perfumes and as a flavoring agent juice used in making soups juice for medicine fruits used in folklore arts as a '*Tantra'* for removing evil spirits

Contd.

Species	Uses
C. aurantium	Leaf, flower, fruit peel and fruit juice used as medicine for skin diseases, gastrointestinal disorder, anemia and also for weight loss Essential from the fruit used as flavouring agent Dried fruit peel used as seasoning Fruit used in pickling Unripe fruit used cuisine
C. decumana	Ripen fruit eaten raw Juice used in making soft drinks Flowers used as perfume industry Wood is used in making tool handles Fruit juice medicinal (ulcers, diabetes and good urinary flow)
C. grandis	Ripen fruit eaten raw Juice used in making soft drinks Flowers used as perfume industry Wood is used in making tool handles Fruit juice medicinal (ulcers, diabetes and good urinary flow)
C. jambhiri	Fruit juice used common lime juice Slices of the fruit used to garnish fish and meat Pickles made from fruits
C. limon	Ripe and unripe fruit edible raw Fruit juice used in making soft drinks Fruits are pickled Essential oil extracted from leaves used in perfumery Juice used in making soups Dried fruit peel used as seasoning fruits used in folklore arts as a '*Tantra*' for removing evil spirits fruits used in folk medicines fruit juice used in cleaning products Juice to cure acidity and stomach disorder
C. maxima	Ripen fruit eaten raw Juice used in making soft drinks Flowers used as perfume industry Wood is used in making tool handles Fruit juice medicinal (ulcers, diabetes and good urinary flow) Juice used in curing bronchitis Leaves mixed with bitter guard, *Anthocephalus cadamba* bark and make paste to treat chickenpox
C. medica	Fruits and fruit juice used as medicine for cold, stomach disorder and also for anemia Fruit juice make into sweet jams Plant is used as root stock for grafting other *Citrus species*
C. pseudolimon	Fruit edible raw Juice for making soft drink Fruits pickled
C. reshni	Fruit used as common lime Juicy fruits used for making refreshing drinks Pickles made from fruits
C. reticulata	Fruits edible Raw fruits used as condiments Fruit juice used in making Sherbet (refreshing soft drink) Essential oil used in bathing Fruits used in making confectionary items
C. sinensis	Ripe fruit eaten Soft drinks made from juice

B. List of uses of different species of focal TFT, recorded in study sites of Indonesia

Species	Uses
Mangifera applanata	Fruits are eaten raw Tender fruits are used as pickle Wood is used as timber
M. caesia	Fruits are eaten raw Fruits are used as hot spices mixture Wood is used as small timber Used as fodder for animal
M. casturi	Fruits are eaten raw, fruit juice is made into jam, juice, taffy Wood is used as small timber Bark /sap is use as dye Leaves are used as fodder to animal
M. foetida	Fruits are eaten raw Fruit are locally processed (tampuyak)
M. griffithii	Fruits are eaten raw Tolerant to drought, floods, and pest diseases
M. havilandii	Fruits are eaten raw, juice used in beverage preparation Wood is used as timber
M. indica	Fruits are eaten raw Use for taffy, use for pickle Leaves are used in rituals Leaves used as fodder Use as medicine (antioxidant)
M. laurina	Fruits are eaten raw Tender fruits are used as pickle Use for medicine Wood is used as timber
M. odorata	Fruits are eaten raw Bio-pesticide (fragrant fruit; susceptible to stem borer) Use for medicine Use as ritual
M. pentandra	Fruit are eaten raw, Adaptable to swampy area,
M. torquenda	Fruits are eaten raw, Tolerant to drought, floods, and pest diseases, Wood is used as small timber, Use for dye, Leaves are used for rituals
M. rufocostata	Fruits are eaten raw Wood is used as timber Root and bark used as diabetic medicine, Susceptible to floods
Garcinia atroviridis	Fruits are dried for used in seasoning Fruits are used as a cure for cough Leaves are used as bio-pesticide Wood is used as timber Used as fodder for animal
G. griffithii	Fruits are used in seasoning Fruit juice is extracted Fruits are used for cosmetic Wood is used as small timber
Garcinia sp.	Fruits are eaten raw Fruit juice is used for seasoning Wood is used as small timber

Contd.

Species	Uses
G. xanthochymus	Fruits are used raw Fruit are used for seasoning Wood is used as timber, Used as fodder for farm animal
C. aurantifolia	Fruits are eaten raw, juice is used in cooking Used as medicine Fruits used as cosmetic use
C. grandis	Fruits are eaten raw Fruits are used for making taffy, jelly, juice, oven rind for prepare candies Leaves used as bio-pesticide Wood is used as timber
C. hystrix	Fruit juice is used as beverage drink with sugar Fruit juice is used for seasoning Fruit used for medicinal purposes Fruit used as shampoo, dried fruit for steam-bath Leaves are used for food seasoning Leaves are used as bio-pesticide Fruits are usedin rituals Used as fodder
C. limonia	Fruits are eaten raw Used for seasoning Fruit juice used as beverage drink Leaves used as bio-pesticide Fruits used in ritual
C. medica	Fruits are used for medicinal purposes Fruits are used in rituals
C. microcarpa	Fruits are eaten raw Fruits used in hot spices mixture Cosmetic use Leaves uses as bio-pesticide
C. reticulata	Fruits are eaten raw Used for seasoning Fruit juice used as beverage drink Leaves used as bio-pesticide Cosmetic use
C. sinensis	Fruits are eaten raw Fruit juice used as beverage drink Fruits are used for medicinal purposes for animal
Nephelium maingayi	Fruits are eaten raw Wood is used as timber Leaves are used as fodder
Nephelium sp.	Seeds are boiled or processed for food, Wood is used as timber Use for dye Leaves are used as fodder

C. List of uses of different species of focal TFT, recorded in study sites of Malaysia

Species	Uses
Mangifera caesia	Fruits are consumed with fresh. Used as food additives. Help increase appetite. Treating cold, body itchiness, high blood pressure and bronchitis Standing trees are worshiped as a ritual to treat itchiness Wood is of good quality and used as building structure, furniture and other woodwork Leaf litter is used as good mulch and fertilizes soil
M. griffithii	Fruits are eaten raw and processed into pickles
M. indica	Fruits are eaten raw, Juice is extracted. Increases appetite. Treat digestion problem

Contd.

Species	Uses
M. laurina	Leaves are used in the treatment of shingles
M. odorata	Fruits are eaten raw, used as food additives. Processed into pickle, jam Wood is used as timber
M. pajang	Fruits are eaten fresh, juice is extracted, processed into pickle and as food additive Bark is used to treat scabies. Fibbers are extracted Wood is used as timber Roots are used to treat winds Sap is used to treat ulcer Seeds are consumed fresh or processed into pickles
M. pentandra	Fruits are processed into pickle, jam and chutney. Used as food additives. and to treat piles Bark is used to treat gastric pain and haemorrhoids. Strengthen men's virility
M. quadrifida	Fruit are consumed fresh. Juice is used in beverage making. Food additives
Mangifera sp.	Fresh fruits are consumed, used as food main cooking ingredients and additives. Removes fish slime and oil-stain Treat itchiness and winds in babies
Garcinia atroviridis	Bark and roots are used in treating high blood pressure Flower is used in treat diabetes Leaves and Fruit are used as Food additive Processed into pickle. Juice is used as a dye mixture Food conditioner Cleaning fish. Brass cleaning To treat itchiness, high blood pressure, fever, diabetes, wounds and venomous sting Relieve dizziness and coughs Feminine intimate part cleansing Post-natal treatment Weight control Leaves are used as Food additives (Tea) Treat high blood pressure Consumed with fresh Seeds are used to treat high blood pressure
G. forbesii	Fruits are used as food additives Fruits used in treating stomach ache, body swelling, relief from sore throat, post natal treatment, family planning, henna mixture, and treat smallpox Flowers are used in body cooling Leaves are consumed fresh Wood is used as timber
G. mangostana	Fruits are used to treat vomiting blood and piles. Family planning Bark is used to treat high blood pressure, haemorrhoids and diabetes Leaves are used as food additives
G. parvifolia	Fruits are consumed fresh. Used as cooking additives. Pickles To treat cough, sore throat and swelling. Post-natal treatment Wood is used for building structure
Citrus aurantifolia	Fresh fruits are consumed raw / made into a beverage used as food additives Leaves are used in bathing to eliminate body odour It is a basic ingredient for rituals /spiritual barrier from bad spirits
C. microcarpa	Fruits used to minimize smell of fish Leaves are also used to minimize fishy smell of fish
Citrus sp.	Fruit is used in treating headache
N. lappaceum	Fruits are processed into pickles and jam. Eaten fresh Wood is used as firewood Leaves are used in the treatment of sore eyes
N. ramboutan-ake	Fresh fruits are consumed and used as food additive Tree sap is used in the treatment of scabies Leaves are used to treat itchiness

D. List of uses of different species of focal TFT, recorded in study sites of Thailand

Species	Uses
Mangifera foetida	Fruits are eaten raw both green and ripe, ripen fruits used in making candy, green fruits used in making salad, used as vegetable in curry and give the sour taste /seasoning Wood is used as timber
M. indica	Green, mature and ripen fruits are eaten raw; Juice is extracted from ripen fruits, made into candy/leather Un-ripen fruits are used in pickle making salad, seasoning (to give sour taste) Green mature fruits are dried-salted, dehydrated and used as condiments Young leaves are used as vegetable
M. cochinchinensis	Fruits are eaten raw both green and ripen Used as root-stock Wood is timber, wood is used for making craft
M. Duperreana	Fruits are eaten raw both green and ripen Used as root-stock Wood is timber, wood is used for making craft
M. hypoleucum	Fruits are eaten raw both green and ripen Used as root-stock Wood is timber, wood is used for making craft
M. lagnifera	Fruits are eaten raw both green and ripen Used as root-stock Wood is timber, wood is used for making craft
M. odorata	Fruits are eaten raw both green and ripen Used as root-stock Wood is timber, wood is used for making craft
Garcinia mangostana	Fruits are eaten raw (green mature, ripen), used for making juice, wine, vinegar, mangosteen candy, cosmetics, dropping fruit (young)-making charcoal, compost Leaves are used to extract dye Seeds are used as medicine
G. atroviridis	Leaves- for cooking Fruit raw and dried for cooking (give the sour taste), juice, tea, pickle, candy medicine
G. cowa	Leaves are eaten as fresh vegetable, young leaves are used for cooking (in soup/curvy)
G. hanburyi	Fruits are used for dying purposes
G. schomburgkiana	Young leaves are used for cooking, Fruits are eaten raw, used in cooking, and pickle making
G. speciosa	Fruits are eaten raw Bark is used for dye making Wood is used for making handle of agricultural implements and for hoe, knife, stick for fencing
Garcinia sp. *(Madan)*	Twigs are specially used in cooking chicken to provide good taste and flavour
Garcinia sp. *(Son kandari)*	Fruit for cooking give the sour taste, juice, tea, medicine, cosmetic
Citrus aurantium	Fruit juice is soup / curry; used medicine
C. hystrix	Leaves are used in seasoning, eaten raw and cooked Fruit / fruit juice used in curry (masman), juice making used as detergent, skin of the fruits put in curvy paste, medicine
C. aurantifolia	Leaves -seasoning Fruit-making juice, juice for cooking (giving sour taste), juice for medicine, preserved, (the whole fruit) pickle
C. maxima	Fruits are eaten raw and used as salad Fruit peel is used in making sweets
C.medica	Fruit juice is used in cooking and as medicine
C.reticulata	Fruits are eating raw, juice is extracted. Fruit peel is used as insect repellent.
C. madurensis	Fruits are eaten raw, juice is extracted, used in cooking, salted-dried fruit
Citrus sp. *(Junkra)*	Fruit juice is used for cooking
Citrus sp. *(Makrud)*	Fruit juice is used for cooking
Citrus sp. *(Somjangkra)*	Fruit juice is used for cooking
Nephelium lappaceum	Fruits are eaten raw, canned, sweet making, fruit husk is used for dye making, Leaves are used in rubber latex setting