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R E V I E W:

Species Diversity of Local Fruit Trees in Kalimantan: Problems of Conservation and Its Development

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ABSTRACT

The decrease in population of local fruit trees due to the forest destruction in some places in Kalimantan is a worrying trend.The genetic diversity of fruits in Kalimantan has been saved partly through indigenous agroforestry, as species cultivated from generation to generation by indigenous people have created miniature forests in the village agroecosystem. However, there is no doubt that the existence of local fruit trees has been threatened by the introduction of a superior fruit cultivars and other commercial plant species such as coconuts (*Cocos nucifera*), oil palm (*Elaeis guinensis*) and rubber trees (*Hevea braziliensis)*. An ex-situ conservation program is proposed for the maintenance of diversity amongst local fruit species.

Key words: Local fruit trees, indigenous agroforestry, conservation, Kalimantan.

INTRODUCTION

Kalimantan is known having wet tropical forest area with high level of flora diversity in the world. Besides timber product, Kalimantan is also rich with various kinds of fruits which half of them is an endemic species (Airy Shaw, 1975; Bompard and Kostermans, 1985; Jarret, 1959a, 1959b, 1960; Seibert, 1988; Siregar *et al*., 1995). The apprehension about disappearance of the local fruits genetic diversity is getting more and more serious lately due to the destruction of forest in some places which are the origin habitat of those fruits. Forest fire, timber exploitation activities, shifting cultivation and the presence of a superior fruit cultivars or commercial plant species such as coconuts (*Cocos nucifera*), oil palm (*Elaeis guinensis*) and rubber trees (*Hevea braziliensis)* are considered to be the major cause of this problem. For all this time, local farmers were accused to be the destructor of forest due to their shifting cultivation activity. However in reality local farmers have an indigenous knowledge in agroforestry system. In this agroforestry system, they cultivated many species of local fruits. But because the attention of local government and some society institution (non governmental organization, NGO) so far is focused on the development of agroforestry system to make it more productive, it is worried that the local fruits in the traditional agroforestry system will disappear. Some special efforts are needed to save those local fruits so that it can be used to develop many species of superior fruits in the future.

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FROM SHIFTING CULTIVATION TO INDIGENOUS AGROFORESTRY

In order to fulfill their basic need, the hinterland societies in Kalimantan applies shifting cultivation system and they have been doing this system hereditary. Besides rice, they are also cultivate various staple plants such as cassava, corn and vegetables concurrently or in rotation. As they doing so, they also planted many kinds of forest seeds that yield wood suitable for building materials. Seeds from the local fruits that they grew in forest were planted in purpose or unpurposely from the fruits that they consumed.

When they left the garden, in fallow stage the plants were still very small and during this period they grew together with many other wild plants. When the farmer came back, the trees that they grew before and other kinds which were considered useful, like trees that were used for building materials, trees where the bees live and sacred trees were not cut down, but their population were added continuously with many kinds of trees that useful for the farmers during they do their activities in that area. This particular area later on, developed and became local societies garden that we known as *lembo, munan, simpukng, pulong bua, dalung bua, tundang kemurlan, karloka kemurlan, tembawang* and *pedukuhan* (Siregar *et al*., 1995; Riswan and Suzuki, 1992).

It is not clearly known when exactly these societies made these kinds of gardens for the first time. But from the process, the age is about the same with shifting cultivation activity it selves, went back to the first time when farming culture is known. In East Kalimantan, the transition from hunting and collecting fruits culture to farming culture is predicted to start since the relationship between native societies or local people and the outsiders in the era of Mulawarman Kingdom around the fourth century.

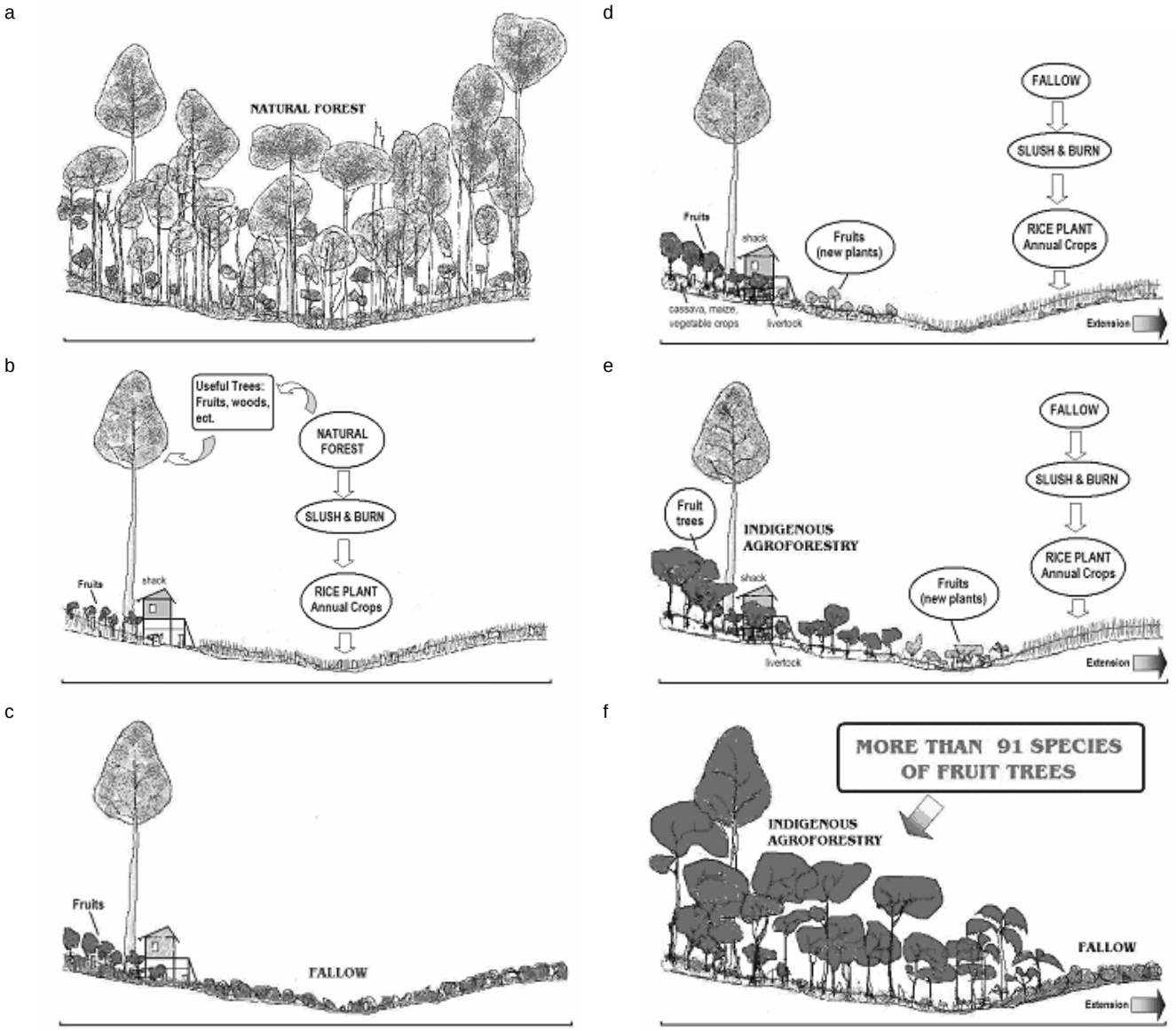

Figure 1. Scheme showing the forming of indigenous agroforestry in Kalimantan: a. Natural forest; b. Slash and burn for planting rice in Shifting cultivation system, some fruit trees species were planted near hovel (1-2 years); c. Fallow stage and young garden around hovel (5 years up); d-e. The stage of fallow-planting rice and fruit trees development; f. Clump of fruit trees in mature garden.

With the accordance of technology transfer in its development, the agro forestry system that they develop was not only managing plants but also cattle business component. There were three kinds of cattle that they breed; chicken, cow and pig. Breeding chickens were done around the hut by making a stable from pieces of bamboo and wood. Generally pig and cow were let to be free around the hut and some of them were placed in the stable. The village which is dominated by Moslem inhabitants like Kutai race in East Kalimantan and Malay in West Kalimantan did not breed pigs.

As a traditional farming, the input-output flow is relatively simple. The input in managing the garden came from its surrounding (high internal input), meanwhile the input from outside is relatively small (low external input). If it is not gardening season, the farmer just visited their garden when the fruits were ripe or harvesting their other garden yield. Pest and disease control, fertilizing and watering were hardly ever done. This model of management gave an assumption that the farmers through their traditional and simple technology have created the forest to be economically and more profitable. This also showed that Kalimantan customs societies in opening the forest were not only taking the benefit from nature but also returning it to the form of ecosystem that more usefull through adoptability and adaptability with their environment so it will created a harmony with ecology, economy and sosio-culture.

THE SPECIES DIVERSITY OF LOCAL FRUIT TREES

If we notice the process of forming an agroforestry, it is natural that in Kalimantan societies agroforestry, there were many differences in age of trees, both planted in purpose or naturally. Besides that the attention to the plants relatively

less, or even with no treatments at all. Mainly the gardens which were far from their resident, there were many kind of clumps, herbs and other low layer plants that grew well. So the diversity of species is one of the specific characters that highlighted in a traditional garden, one of the characteristic which is also owned by tropical forest. Even if we look more detail from its structure vertically or horizontally, traditional gardens in Kalimantan are similar to tropical rain forest.

It is not easy to give a clear limitation for the kind of trees that produce fruits. However this paper will discuss more about wooden fruits that match with the category of Levang and de Foresta (1991), Prosea (1992, 1993) both as a major or minor functions, or the fruits consumed by local people as fresh fruits. Some kinds of fruits that can't be eaten but came from a genus which generally known as fruits yielding group were put in the discussion, due to their importance as gene pool source to improve their group like the *Artocarpus, Mangifera, Baccaurea* and *Durio* genus. The fruits that belong to banana class (*Musa* spp.) and palm class (Palmae) were not discussed in this paper.

One of the exploration result done by the writer in 1991 and added by the result of other research done by other researchers in Kalimantan there were 130 species of fruits noted. About 85 species of them were presumed native of Kalimantan signed by their wild presence in the forest. Ninety one species has been developed in the local societies garden and about a half of them nowadays were rarely found in the forest (Table 1).

Table 1. Species diversity of fruits trees in Kalimantan and their utilization

Genus	Number of species	Species harvested for sale	Edible non economic species	Non edible	Location		
					Forest	garden	Forest & garden
Artocarpus	15	8	7	0	4	3	8
Baccaurea	12	3	9	0	4	1	7
Citrus	6	4	2	0	0	6	0
Durio	7	2	3	2	2	1	4
Garcinia	12	1	5	6	6	3	3
Mangifera	13	8	4	1	1	5	7
Nephellium	6	3	3	0	1	2	3
Other sp.	59	16	43	0	21	24	14
Total	130	45	76	9	39	45	46

From those 130 species of fruits trees which were noted, about 45 species of them were sold in the local market after harvest. But most of them were taken for self consumption without having economic value because of their sour taste like from *Baccaurea* group. Some of them can not be eaten, but classified as fruits groups because one of the member is commonly classified as fruit which have high economic value like the *Garcinia* genus.

There were 15 species of *Artocarpus* genus, 11 species of them have been developed in the local societies garden and 12 species grew wild in forest (Table 1). As a comparison Jarret (1959a, 1959b, 1960) in Seibert (1988) found about 20 species of *Artocarpus* genus in Kalimantan, six species of them were endemic. *Artocarpus integer* were mostly planted in traditional garden around the forest. Generally, in the garden around the houses or yard we can found *A. heterophyllus* which predicted as a cultivar that came from outside the island. Both *A. integer* or *A. heterophyllus* were hoped to give cash income by their owner. Some endemic species (*A.nitidus, A. abtusus and A. odoratissimus*) have developed in small quantity at the garden, although they still can be found in the forest.

Baccaurea is a kind of fruit that can be found easily. There were about 12 species of them. About 11 species grew wild in the forest and 8 species of them have been developed in the garden. Most of the yield from this class were for self consumption, and not the kinds that gave cash income. As a result, *Baccaurea* population were very rarely found in the local societies garden. One of the species that the yield sometimes can be sold is *Baccaurea motleyana* that familiar in Java as "menteng". Six species noted as *Citrus* spp. was predicted as an introduce species because they were not found widely in forest.

Durio is a species of fruits that very familiar in Kalimantan and outside Kalimantan. Two species that were well known and give a lot of contribution to the farmers income were *D. zibethinus* which is known as "durian" and *D. kutejensis* known in East Kalimantan as "lai". Many *D. zibethinus* in Kalimantan have varies in, taste, smell and the fruit flesh color. Beside the two species above, some species from *Durio* were often consumed by family, but were not generally sold like 'karatongan' (*D. oxleyanus*), 'lahung' (*D. dulcis*) and 'durian udas' (*D. graviolens*). Many species from *Durio* that inhabited Kalimantan forest as previously reported were not found in this studies. These species mainly the uneatable species, they were only appreciated just for their wood value. For comparison, Seibert (1988) noted more than 18 species of *Durio* genus inhabit Kalimantan and 14 species of them were endemic.

Garcinia genus has many members, about 11 species. Nine species of *Garcinia* genus grew wild in the forest, and 6 species have been cultivated in the garden. In fact, only a few species of this genus were eatable, one of them has been known as 'manggis' (*Garcinia mangostana*) where many of its cultivar come from outside region.

Thirteen species of *Mangifera* still can be found frequently in the inland of Kalimantan. Twelve species of them have been planted in the garden around the forest and in the local societies house yard. *M applanata* was the only species which was not found in the garden. Species diversity of *Mangifera* in this article were only a half from 24 species from *Mangifera* genus that have been reported in Kalimantan (Seibert, 1988; Bompard and Kostermans, 1992).

M. indica and *M. odorata* are popular fruits. Beside those two species, *M. pajang* was frequently found in the indegenous agroforestry in East Kalimantan. So frequently *M. foetida* was found in 'Pedukuhan' - Kendawangan West Kalimantan. *M. indica, M. odorata, M. pajang and M. foetida* were the species that hoped to gave a cash income to the garden owners. *Mangifera kasturi* is an endemic species which is appreciated enough in South Kalimantan (Mac Kinnon *et al*, 2000). Another species is *M. gedebe* that frequently found and grew naturally around Mahakam River East Kalimantan. Many of this last species have been cut down and their woods were taken for furniture materials. Their young fruit were consumed as 'sambal' (traditional hot delicacy) material. *M. applanata* that grew naturally in peat forest in West Kalimantan also found planted in the garden.

Only six species of *Nephelium* were found in this study. In fact, according Seibert (1988), Kalimantan with 22 species of *Nephelium* is a center of its diversity. About 22 species were known and 16 of them can be found in Kalimantan, including eight endemic species. However, in fact in one species it is very frequently known having many genetic variation. As an example, 'rambutan' (*N. lappaceum*) which is generally cultivated, having not less than 15 cultivar variation in Mekarjaya village; Sambas Regency, West Kalimantan. The farmer rely so much on

this species to support the economy of the family. Other species which are predicted having many variation are *N. maingayi* and *N. Ramboutan-ake*. These two species were frequently found in the local societies garden and in their house yard.

There are still many fruit trees in Kalimantan that have high value and they are valuable asset that need proper attention. Some of them produce fruits that economically gave cash income for the farmers like *Annona muricata, Averrhoa bilimbi, A. carambola, Manilkara zapota, Persea americana, Psidium guajava, Sandoricum koetjapi* and *Syzygium* spp., most of the latest species were introduce species.

Many of 'Lansat' (*Lansium domesticum*) or known as 'duku' outside Kalimantan, grew in local societies garden in East Kalimantan. One of the cultivar from this species which is quite familiar around Samarinda, but now seldom found is 'lansat air putih' compared with its family from the same species like cultivar from Lebak Cilong and Kahala-East Kalimantan, this cultivar is known having sweeter taste.

Table 2. Species of fruits trees found in Kalimantan.

No.	Species	Species harvested from natural forest	Species harvested from forest garden	Species harvested for sale	Edible non economic species	Habitat
1	*Alangium javanicum* (K. & V.) Wang.	+				F
2	*Alangium nobile* Harm.	+				F
3	*Anacardium occidentale* L.		+	+		A
4	*Annona muricata* L.		+	+		A
5	*Annona squamosa* L.		+			A
6	*Antidesma bunius* (L.) Sprengel	+	+	+		F, A
7	*Antidesma* sp.		+			A
8	*Artocarpus altilis* (ParA.) Forst.		+	+		A
9	*A. anisophyllus* Miq.	+	+	+		F, A
10	*A. dadah* Miq.	+				F
11	*A. elasticus* Reinw. ex Blume	+	+	+		F, A
12	*A. heterophyllus* Lam.		+	+		A
13	*A. integer* (Thunb.) Merr.	+	+	+		F, A
14	*A. kemando* Miq.	+	+	+		F, A
15	*A. lanceifolius* Roxb.		+	+		A
16	*A. nitidus* Trecul	+	+			F, A
17	*A. obtusus* Jarrett.	+	+			F, A
18	*A. odoratissimus* Blanco	+	+	+		F, A
19	*A. scortechinii* King	+				F
20	*A. tamaran* Becc.	+	+			F, A
21	*A. Teysmannii* Miq.	+				F
22	*Artocarpus* sp.	+				F
23	*Averrhoa bilimbi* L.		+	+		A
24	*Averrhoa carambola* L.		+	+		A
25	*Baccaurea angulata* Merr.	+				F
26	*B. bracteata* M.A. var. *bracteata*	+	+			F, A
27	*B. dulcis* (Jack.) Muell. Arg.		+			A
28	*B. edulis* Merr.	+				F
29	*B. kunstleri* King ex Gage	+				F
30	*B. lanceolata* (Miq.) Muell. Arg.	+	+			F, A
31	*B. macrocarpa* (Miq.) Muell. Arg.	+	+	+		F, A
32	*B. motleyana* Muell. Arg.	+	+	+		F, A
33	*B. parviflora* (Muell. Arg.) Muell. Arg.	+	+			F, A
34	*B. puberula* (Miq.) Muell. Arg.	+	+			F, A
35	*B. racemosa* (Reinw. Ex Bl.) Muell. Arg.	+	+	+		F, A
36	*B. trigonocarpa* Merr.	+				F
37	*Belucia axinanthera* Triana	+				F
38	*Blumeodendron tokbrai* (Bl.) J.J. Smith	+				F
39	*Bouea oppositifolia* (Roxb.) Meisn.	+	+			F, A
40	*Canarium* sp.		+			A
41	*Chisocheton sandoricarpus*		+			A
42	*Citrus aurantifolia* (Chris. & Panz.) Swi.		+	+		A
43	*C. aurantium* L.		+	+		A
44	*C. maxima* (Burm.) Merr.		+	+		A
45	*C. microcarpa* Bunge.		+	+		A
46	*C. nobilis* Lour.		+			A
47	*C. reticulata* Blanco.		+			A
48	*Dacryodes rostrata* (Bl.) H.J. Lam	+	+			F, A
49	*Dialium indum* L.	+	+			F, A
50	*Dimocarpus longan* Lour. var. malaiensis	+	+	+		F, A
51	*Diospyros bantamensis*	+				F
52	*Dracontomelon dao* (Bl.) Merr. & Rolfe.	+	+			F, A
53	*Durio dulcis* Becc.	+	+		+	F, A
54	*D. graviolens* Becc.	+			+	F
55	*D. griffithii*	+				F
56	*D. kutejensis (Hassk.) Becc.*	+	+	+		F, A
57	*D. oxleyanus Griff.*	+	+		+	F, A
58	*D. zibethinus Murray*	+	+	+		A
59	*Durio sp.*	+	+			F, A
60	*Elaeocarpus floribundus Bl.*	+	+			F, A

Table 2. Species of fruits trees found in Kalimantan (*lanjutan*).

No.	Species	Species harvested from natural forest	Species harvested from forest garden	Species harvested for sale	Edible non economic species	Habitat
61	*Elaeocarpus glaber* Blume	+				F
62	*Elaeocarpus petiolatus* (Jack.) Wallich.	+				F
63	*Eugenia spicata* Lamk.		+			A
64	*Euodia minahasae*		+			A
65	*Ficus glomerata* Roxb.	+				F
66	*Flacourtia rukam* Zoll. & Moritzi	+		+		F
67	*Garcinia bancana* Miquel	+				F
68	*G. dulcis* (Roxb.) Kurz.	+	+			F, A
69	*G. forbesii* King	+	+			F, A
70	*G. havilandii*	+				F
71	*G. nervosa* Miq.	+				F
72	*G. parvifolia* (Miq.) Miq.	+	+			F, A
73	*G. prainiana* King	+				F
74	*G. rostrata*	+				F
75	*G.mangostana* L.		+			A
76	*Garcinia* sp.	+				F
77	*Garcinia* sp.		+			A
78	*Garcinia* sp.		+			A
79	*Lansium domesticum* Corr.		+	+		A
80	*Lepisanthes alata* (Bl.) Leenh.	+	+			F, A
81	*Lepisanthes amoena* (Hassk.) Leenh.	+				F
82	*Litsea garciae* Vidal	+	+			F, A
83	*Madhuca betis*	+				F
84	*Mangifera applanata*	+				F
85	*M. caesia* Jack.	+	+	+		F, A
86	*M. casturi*	+				F, A
87	*M. decandra* Ding Hou		+			A
88	*M. foetida* Lour.	+	+	+		F, A
89	*M. gedebe* Miq.	+	+		+	F, A
90	*M. indica* L.	+	+	+		F, A
91	*M. laurina*		+			A
92	*M. longipes* Griff.		+			A
93	*M. odorata* Griff.		+	+		A
94	*M. pajang* Kosterm.		+	+		A
95	*M. parvifolia* (Boerl. & Koords.)	+	+			F, A
96	*M. quadrifida* Jack.	+	+			F, A
97	*Manilkara kauki* (L.) Dubard.		+			A
98	*Manilkara zapota* (L.) P. van Royen		+			A
99	*Microcos hirsuta* Burret	+				F
100	*Muntingia calabura* L.	+	+			F, A
101	*Nephellium cuspidatum* Bl. (*N. cuspidatum* Bl. var. *cuspidatum*)	+	+			F, A
102	*N. lappaceum* L.		+	+		A
103	*N. maingayi* Hiern.	+	+	+		F, A
104	*N. ramboutan-ake* (Labill.) Leenh.		+	+		A
105	*N. reticulata* Radlk.	+			+	F
106	*N. uncinatum* Radlk. Ex Leenh.	+	+			F, A
107	*Palaquium leiocarpum*	+				F
108	*ParArtocarpus venenosus* (Z. & M.) Becc.	+				F
109	*Passiflora quadrifida*		+			A
110	*Persea americana* Miller		+	+		A
111	*Phyllanthus acidus* (L.) Skells.		+			A
112	*Phyllanthus emblica* L.	+				F
113	*Pogostemon hortensisi*	+	+			F, A
114	*Pometia pinnata* J.R. Forster & J.G. Forster	+	+			F, A
115	*Psidium guajava* L.		+	+		A
116	*Rhodomyrtus tomentosa* (Aiton) Hassk. var *tomentosa*	+				F
117	*Sandoricum borneense* Miq.	+				F
118	*Sandoricum emarginatum*	+				F
119	*Sandoricum koetjapi* (Burm.f) Merr.		+	+		A
120	*Sarcotheca diversifolia* (Miq.) Hall.f.	+				F
121	*Spondias dulcis* Soland. ex Forst.f.		+			A
122	*Spondias mombin* L.		+			A
123	*Syzygium aqueum* (Burm.f) Alston.		+	+		A
124	*Syzygium malaccense* (L.) Merr. & Perry.		+			A
125	*Syzygium polyanthum* (Wight) Walp.	+	+			F, A
126	*Tamarindus indica* L.		+	+		A
127	*Tetramerista glabra* Miquel.		+			A
128	*Willughbeia coriacea* Wallich	+				F
129	*Willughbeia firma* Bl.	+	+			F, A
130	*Xerospermum noronhianum* (Bl.) Bl.	+				F

Notes: + = presence; F = forest; A = indigenous agroforestry.

CHALLENGES IN THE FUTURE AND THEIR SOLUTIONS

Basically, local societies in the inland of Kalimantan had known the agroforestry system for a long time. This indigenous knowledge were passed from generation to generation as a major effort in supporting the needs of their family. Some form of agroforestry aged thousand of years and formed a climax forest vegetation. But most of this farming business are still managed subsistently, only to fulfill their own needs. This kind of agroforestry model is generally indicated by the varies composition of species and having less economic value. The agroforestry system that is market oriented generally have more homogen composition and have more economic value, such as rubber (*Hevea brasiliensis*), coconut (*Cocos nucifera*), *Arenga pinnata*, banana (*Musa* spp.) and oil palm (*Elaeis guinensis*). Some modernization efforts and the development of an indigenous agroforestry done by the government and plantation companies also follow this model.

Modernization of an agroforestry system to improve land productivity is not a wrong step. But if this system develop quickly without regard or neglecting those species of local fruits, we can say for sure that the local fruits which fill those agroforestry system sooner or later they will not be around anymore. The farmers will be cutting away these local fruits due to their low economic value. With the increasing of the population number, limited farm land, and the existence of a better commodity from outside region, the local fruits will be victimized. The government policy in plantation and forestry to develop a commercial plants are economically pleasant, but in the same time it is the beginning of a serious local gene pool erotion.

The existence of 35 species that can only be found in the forest and haven't been cultivated by the local societies will be critical as progressively the increasing rate of forest destruction in Kalimantan. Indonesian Botanic Garden under the management of Indonesian Institute of Science (Bogor, Cibodas Purwodadi and Bali), have just collected 53% from all the species found in this study. However, not all of those collections came from cultivar/variety that grew in Kalimantan. In reality the traditional societies in Kalimantan with their traditional garden plays an important roles in saving the gene pool of local fruits in Kalimantan.

By giving more attention to the condition, concept of ex-situ concervation (conservation outside original habitat) for local fruits is becoming an option and a best decision to take. This concept does not need wide land and can be monitored tightly, compared to in-situ conservation concept (conservation in original habitat) that requirs very wide land. Generally local fruit trees are grows spreadly in their original habitat and it is quite difficult to determine a precise area for its in-situ conservation.

Some efforts of ex-situ conservation for the local fruits of Kalimantan, i.e. (i) Arboretum or botanic garden. Botanic garden concept has been developed by Indonesian Institute of Science (LIPI) by the name of "Kebun Raya" in West Java (Bogor and Cibodas), East Java (Purwodadi) and Bali (Bedugul). Besides their function in conservation, the concept of “Kebun Raya" also plays a part in conducting activities such as inventaritation, eksploration, collection, research and development of species which economicaly potential for their sustainable use in the future. By selecting an appropriate habitat for these fruits species, hence we will be able to collect many species. Today “Kebun Raya” has also rounded into an education and recreation target, so that enabled it to yield income from ticket selling, which is very useful in defraying management of garden. Challenges in establishing a new “Kebun Raya” possibly comes from the availability of a standard location for a botanic garden, human resource in certain skills such as management, research and development and also the availability of fund. (ii) Development of an indigenous agroforestry (such as *lembo, munan, simpukng, pulong bua΄, dalung bua΄, tundang kemurlan, karloka kemurlan, tembawang* and *pedukuhan*) to be come a conservation area with an adequate incentive for its owner. A complex of indigenous agroforestry could occupied hectares of area and own by some family in the same offspring. We can select from the existing agroforestry complex for developing and enriching in its species diversity. Local societies or garden owner with their local knowledge in flora can be trained in the field of taxonomy and language to become gardener, researcher assistant or guide with adequate incentive. (iii) Conservation through cultivation in parks, town garden, campus, roadside, experimental gardens and yard.

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