

ITTO PROJECT PD 16/99 Rev. 2 (F) • PHASE III

**DEVELOPMENT OF LANJAK ENTIMAU  
WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA  
A STUDY ON THE CULTIVATION AND DOMESTICATION  
OF INDIGENOUS ORNAMENTAL, MEDICINAL PLANTS  
AND FRUIT TREES**

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## EXECUTIVE SUMMARY

This is a pilot study to investigate the potential of forest species of ornamental and medicinal value. It was carried out in Batang Ai National Park (BANP) and Lanjak Entimau Wildlife Sanctuary (LEWS), including the buffer zones of the two areas. The objectives of this study were to initiate a study on cultivation and domestication of non-timber plant species of economic potential, collect information on the performance of species under non-forest conditions, encourage propagation and sales of ornamentals and medicinal plants at the community level to benefit the local participants, and to use the information gathered and nursery techniques learned as a guide for further research.

A total of 172 species of plants were collected for the study. Out of this, more than 57 species comprising of more than 460 individuals were planted in the mini garden. Apart from their ornamental value, many also possess medicinal properties. More than 20 species, mainly herbs, were potted and maintained at the BANP Hq. to study their performance under nursery conditions. Some of the species were directly planted in the mini garden.

The criteria used in selecting ornamentals plants include good form, shape, and size of the plants, colourful flowers and fruits, attractive colours and arrangement of the foliage, good branching pattern, and ease of propagation and domestication. Based on these criteria, several categories of plants were identified and collected, mainly belonging to the families of Araceae, Begoniaceae, Zingiberaceae, Gesneriaceae and Rubiaceae. Environmental parameters like air temperature, air humidity, light intensity and soil pH were recorded both in the forest and at the nursery so that the conditions under which the plants grow can be compared.

This study on the cultivation and propagation of ornamental and medicinal plants requires long term efforts to achieve results, and is best carried out collaboratively between the Project and the local communities. The commercialization of ornamental and medicinal plants is most likely to benefit interested local participants at the local level.



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# GLOSSARY

Local Terms/Abbreviations	Meaning
Ai	Water
BANP	Batang Ai National Park
Batang	Main River
Baya	Crocodile
BKNP	Betung Kerihun National Park
Bukit	Hill
cm	centimeter
FRC	Forest Research Centre
Hq.	Headquarters
ITTO	International Tropical Timber Organization
LEWS	Lanjak Entimau Wildlife Sanctuary
UNESCO	United Nations Educational, Scientific & Cultural Organization.
m	meter
asl	above sea level
Ng	river mouth or confluence
Sg	River
Tinting	Ridge
TBCA	Transboundary Biodiversity Conservation Area
Ulu	upriver, interior

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## 1.0 INTRODUCTION

This is a pilot study initiated under the ITTO Project PD 16/19 Rev.2 (F) – Development of Lanjak Entimau Wildlife Sanctuary (LEWS) as a Totally Protected Area, Phase III. The study was included at the recommendations of Forestry Department Sarawak, the Executing Agency of the project, with emphasis on the study of ornamental and medicinal plants that are available in LEWS and Batang Ai National Park (BANP). Although many local forest plants are known to possess the potential to be used as ornamentals and herbal medicines, very few have actually been introduced for commercial purposes, because little proper studies on their propagation and domestication have been undertaken, and little effort has been made to tap their economic potential.

In Malaysia and many other tropical countries, the policies of many governments have been primarily concerned with the utilization of the forests for timber production. However, in recent years, the scope of sustainable forest management (SFM) has broadened, and greater interest has been shown on the development and utilizations of non-timber forest species. For many generations, the use of well-known forest produce such as fruits, vegetables and medicinal plants in Sarawak has almost been exclusively confined to the rural communities to sustain their livelihoods.

The increasing popularity of local produce markets, such as the Sunday Markets in Kuching and other towns in Sarawak, have provided the opportunities for the local farmers from the rural communities to market their produce. This produce are either directly obtained from the wild, or cultivated in their home gardens and farms. The local produce markets have become an important venue for the introduction and commercialisation of many local fruits that were previously unknown to most urban residents. Seasonal local fruits, such as *Canarium odontophyllum* (Wernh.) Merr. (Dabai), *Dacryodes rostrata* (Bl.) H.J. Lam (Kemayau), *Baccaurea macrocarpa* (Miq.) M.-Arg. (Puak), *Elateriospermum tapos* Bl. (Perah) and *Baccaurea angulata* Merr. (Uchong), have become increasingly popular among the urban consumers. Similar trend has also been observed in the ornamental trade where many orchids, pitcher plants, ferns and other herbs, including even many protected species, are brought to the markets and openly sold.

The current scenario has shown that there is a constant demand for ornamentals and medicinal herbs among a wide cross section of the urban growers and users, judging by the increasing varieties and quantities of plants that are sold, together with the exotics.

In spite of the abundance of indigenous knowledge on the use of forest plants, research and documentation of information are still far from being complete



(e.g. Christensen, 2000; Pearce *et al.*, 1985; Chai, 1975 & 1978; Van Steenis, 1958; Jabatan Pertanian Sarawak, 1990; Kuek, 2003). Advances in biotechnology are dependent on such information being made available. For over a decade, the long and costly research for developing and marketing new biotechnology products has become a disadvantage to small firms. Frequently, new products have been met with resistance from the public due to lack of knowledge and often misinformation (Giles & McLaughlin, 1997). Basic research and baseline data are therefore elementary to the efforts to achieve success in biotechnology.

## **2. OBJECTIVES**

The objectives of the study are:

1. To initiate a study on the cultivation and domestication of non-timber plant species of economic potential;
2. To collect information on the performance of species under non-forest conditions, through trial planting and observations in the nursery;
3. To encourage propagation and sales of ornamentals and medicinal plants at the community level to benefit the local participants;
4. To use the information gathered and nursery techniques learned as a base for further research.

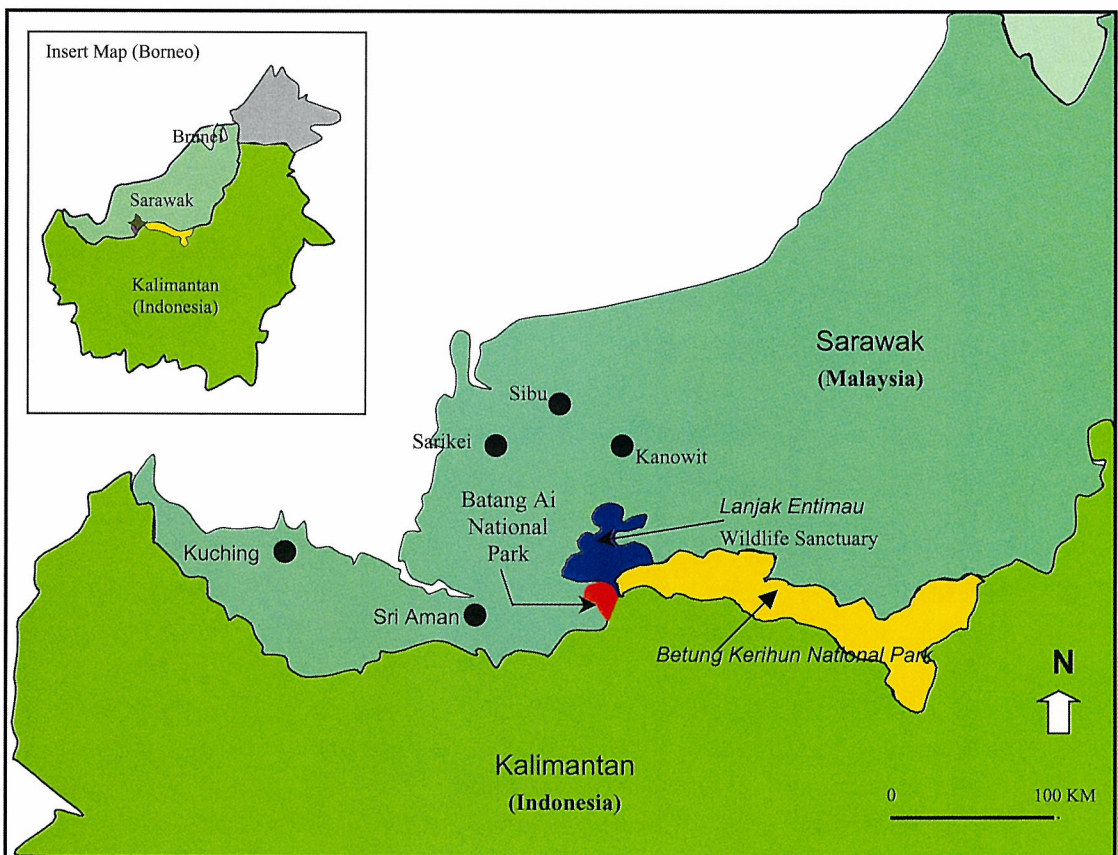
## **3. STUDY SITES**

This study was carried out in the Batang Ai area covering Batang Ai National Park (BANP) and Lanjak Entimau Wildlife Sanctuary (LEWS), including the buffer zones of the two areas (Figure 1). Batang Ai National Park was gazetted in 1991 and recently extended, presently with an area 32,000 ha. It was included in the Trans-boundary Biodiversity Conservation Area (TBCA) together with LEWS and Betung Kerihun National Park (BKNP) in West Kalimantan in 2002. The TBCA was also nominated as a UNESCO Trans-border World Natural Heritage Site in 2003. Prior to its gazettment, BANP was home to the Iban communities who lived in seven longhouses, making use of the resources to support their livelihoods. They also cleared many areas in the forest for farming, so much so that about 60 % of the Park is covered by secondary forest of varying ages.

Primary mixed dipterocarp forest (MDF) is concentrated in areas with steep terrain and poor sandy clay soils with little prospect for agriculture. The forest litter is thick over a few centimetres of humus. Riparian forest is much less extensive along the riverbanks with alluvial soils, but is an important habitat for herbaceous flora. A recent floral inventory in the MDF and old secondary forest has shown that the forests are rich and diverse in species, including numerous herbs (Bibian & Chai, 2004). Dominant trees in the riparian forest

include Kasai (*Pometia pinnata* Forst.), Empelajau (*Pentaspadon motleyi* Hook.f), Babai (*Saracca indica* L.), Pitoh (*Swintonia acuta* Engl.), and Segera (*Aglaia* sp.). Together with Ensurai (*Dipterocarpus oblongifolius* Blume), Engkabang (*Shorea macrophylla* P.S. Ashton) and Jambu air (*Eugenia* sp.), these trees not only provide shade but also fruits to the aquatic fauna (Ivy, 2004). Species of the Araceae (Sungkut-ungkut) and *Selaginella* (Kaki hujan) are common among the herbs. Palms are dominated by Pinang raung (*Pinanga rivularis* Becc.).

**Figure 1: Location of LEWS and BANP**



## 4.0 METHODOLOGY

### 4.1 Field surveys and Scope of Study

Several surveys and collecting trips were carried out between April and July 2002 to the following areas in the Batang Ai watershed (Figure 2):

- i. Batang Ai river system: Ng Mujan, Wong Mepal, Tinting Kemuyang, Bt Rirong, Sg Bebiyong Mit, Ng Lelayang;
- ii. Sg Lubang Baya river system: Wong Pedalai trail, Ng Keluit;
- iii. Ng Beretik, Ng Wong Tibu and Lubang Baya Ranger Station;
- iv. Sg Buran and Ng Delok.

These areas are occupied by MDF, secondary forest and partially disturbed forest on Tinting Kemuyang and Bukit Rirong; and riparian vegetation on recent fertile alluvial deposits, ranging from 40 m a.s.l. to below 1000 m a.s.l. The cool and moist environment in the riparian forest supports a rich and diverse variety of colourful and attractive herbs and palms, many of which also possess medicinal properties.

The scope of the study included:

- i. Distribution and abundance of species with ornamental and medicinal values;
- ii. Identification of potential species, noting their habits and morphological characteristics;
- iii. Collection, propagation and domestication of selected species;
- iv. Establishment of a nursery and a mini-garden to enable the studies and trial planting to be carried out;
- v. Continuing the planting of fruit trees that was initiated under the study on cultivation of indigenous crops.



**Figure 2: Surveys and collection areas**



**Legend:**

- ★ Collection area
- ★ Nursery site
- ▲ Lubang Baya Ranger Station

## 4.2 Collecting and Handling

Ornamental plants must possess the following characteristics:

- i. Good form, shape and size of the plant;
- ii. Colourful flowers and fruits;
- iii. Attractive colours and arrangement of the foliage;
- iv. Good branching pattern;
- v. Ease of propagation and domestication.

Many of the species with medicinal properties are also decorative, thus enabling the studies of these two groups of plants to be carried out simultaneously.

Based on the above characteristics, several categories of plants were identified and collected. These included trees and shrubs, palms, climbers, ferns and numerous herbs -mainly belonging to the families of Araceae, Begoniaceae, Zingiberaceae, Gesneriaceae, and Rubiaceae. At each site, environmental parameters of the air temperature (°C), air humidity (%), light intensity (LUX) and soil pH were recorded to study the optimal conditions in which the plants grow.

Collections were made of the following materials for propagation in the nursery:

- i. Mature fruits and seeds, if available;
- ii. Wildings and suckers;
- iii. Vegetative cuttings

Where the collections involved the entire plant, it was important to first ensure that there was a sizeable population of the species in the wild. This was to prevent total loss of genetic material. Collections were normally carried out in the early morning to avoid shock and reduce transpiration. Each plant was carefully removed by digging with a *parang* or bush knife, with minimum damage to the roots. The root ball together with some soils was wrapped in big leaves, newspapers or a small polythene bag (15 x 20cm), and securely tied, with the shoots exposed. Where necessary, the specimen would be kept moist by sprinkling it with a little water. For palms and gingers, only small suckers were collected. To prevent water loss, each sucker was wrapped in an old newspaper, mostly with the shoots exposed.

Succulent herbs like *Begonia* (Begoniaceae), aroids (Araceae) and gingers (Zingiberaceae) are associated with cool and damp habitats on the forest floor, while palms have a less restricted distribution in various types of forest. Only one species of palm, *Pinanga rivularis* Becc. (Pinang raung) was encountered in the sandy alluvium along the riverbanks.

Decorative trees include *Pentaspadon motleyi* Hook. f (Empelajau), *Swintonia acuta* Engl. (Pitoh), *Barringtonia lanceolata* (Ridl.) Payens (Putat), *Saraca indica* L. (Babai) and *Archidendron clypearia* (Jack) I. Nielson (Kenarang). Their mature seeds were collected from the ground or by climbing the mother trees. The seeds were cleaned in water when ever necessary and then kept in paper bags.

Vegetative cuttings of green stems were conducted on *Ficus deltoidea* Jack (Tangkai beritu), *Justicia gendarussa* Burm. f. (Pakit) and *Cassia alata* L. (Serugan). It is important to use a sharp cutter (secateurs) to avoid rotting problem when these cuttings are propagated in the sand bed. Cuttings must also be obtained from a healthy plant, and kept in plastic bags to avoid moisture loss and dehydration.

Before potting, the roots of seedlings or wild herbs needed to be trimmed, and damaged or broken parts such as shoots, twigs and leaves were removed. For vegetative cuttings, the leaves were clipped off as appropriate to prevent water loss. The cuttings were divided into short sections each with 1 to 3 nodes. Suckers of succulents are also sensitive to water loss. For gingers and ferns, the shoots and some of the leaves were cut off and the roots trimmed.

#### **4.3 Information, Numbering and Recording Systems**

While collecting the planting materials, notes were taken on their habitats and environmental factors. Light intensity (LUX), temperature (°C) and air humidity (%) were taken in different areas of collection. Information was also taken of the soil types, soil pH, forest types and general appearance of the area. These data will help us to understand the optimal environmental conditions under which the species grow and thrive.

Each plant material collected was recorded and tagged with a temporary plastic label with a number, and followed by the local name, e.g. *ITTO 001/Sungkut unγκut ai*. The following information was recorded in a record book:

- i. Collection number;
- ii. Date of collection;
- iii. Plant name (family, botanical and/or local name);
- iv. Locality;
- v. Altitude;
- vi. Habitat;
- vii. Forest type;
- viii. Plant classification;
- ix. Type of material collected;



- x. Site environment;
- xi. Light density;
- xii. GPS reading;
- xiii. Air humidity
- xiv. Air temperature

## 5.0 NURSERY PRACTICES

### 5.1 Establishment of nursery

A nursery for propagation, potting and trial of ornamentals and fruit trees was established at the BANP headquarters at Ng Delok. The facilities in the nursery included:

- i. A small office and a store;
- ii. Three shed-houses;
- iii. One mist propagation shed with sand beds;
- iv. A water tank and a piping system for watering.

The nylon net used to construct the nursery shed is able to shade out 35% of sunlight. To create different light conditions, the three sheds were each covered with one layer, two layers and three layers of the nets respectively.

As the collecting sites are in the vicinities of the Park Hq., it was possible to get the material to the nursery within 3 days by long boats in the early morning hours, thereby minimising stress and water loss. The Lubang Baya Ranger Station was used as a transit point, if materials could not be transported immediately to the nursery.

### 5.2 Potting mixtures

All seedlings, suckers and wildings were first potted in black polythene bags of various sizes, depending on the requirements. Generally, the medium used for potting is a mixture of topsoil, organic compost and sand in the ratio 3:1:1. However, for *Begonia* and *Pinanga rivularis*, more sand was added to make up the sand and topsoil ratio of 3:1. Only small amounts of organic compost were added to the medium. Processed oil palm waste that is marketed as a natural growth medium was tried in place of the organic compost, but the results were not satisfactory. This medium was found to require more frequent watering than the organic compost medium. A simple test later using Hanna Soiltest Kit also indicated that it contained almost zero nitrogen ( $\text{NO}_3$ ), making it unsuitable for growing seedlings.

Sand beds were used for seeds and vegetative cuttings. Coarse river sand obtained locally was found to be a more suitable medium than the fine sand. This was probably due to its greater porosity and more air space that makes it able to spread water evenly. This ensures the sand beds were maintained at the optimal moisture condition. Rooting of cuttings will not occur if the sowing medium is dry. Wet sand will dampen the root and encourage the growth of lichens and fungus, and will eventually cause the seeds and cuttings to grow mouldy and rot. The sand beds were mist sprayed twice a day at 8.00 am and 3.00 pm for 3 to 5 minutes, depending on the temperature and intensity of light.

Potted succulents that were sensitive to light and water loss were kept in the shed with the lowest light penetration, while species collected from open areas or young secondary forest that are more light tolerant, were nurtured under the shed with single layer netting.

## **6.0 OBSERVATIONS**

### **6.1 Maintenance and Monitoring**

All the potted plants in the nursery were monitored for their growth and survival. Plants under the shed houses were watered twice a day at 8.00 am and 5.00 pm. Readings on air temperatures (°C), relative air humidity (%) and light intensity (Lux) at four different positions were supposed to have been recorded 5 times a day, at two-hourly intervals starting at 8.00 am at various locations outside the nursery, under the mist propagation shed and nursery sheds with nettings respectively. Unfortunately, the locally employed nursery workers did not carry out the instructions diligently, so that the data obtained were faulty and could not be analysed.

### **6.2 Trial Planting and Potting**

A mini garden approximately 40 m x 20 m in area was established next to the nursery for trial planting, to study the performance of selected species of ornamental and medicinal plants, and their abilities to adapt to the new environment outside the forest and the nursery. This is a part of the plant introduction and domestication process. If successful, the mini garden, with a good selection of interesting and well-maintained forest plants, will be able to serve as a new attraction to visitors to the Park, and help to promote eco-tourism, nature education, and sustainable utilization of forest resources.

Prior to the planting, a layout plan was prepared, keeping in mind the different varieties of species to be planted. The selected plants comprised of aroids, ginger, ferns, and other herbs; palms and small shrubs. Other species were included as feature plants in order to create an aesthetic effect. After the planting, a sheet of nylon netting was put up as a temporary sunshade. The shade was removed after about three months when the plants had become established and were well adapted to the open condition. The exceptions were species of Araceae and Zingiberaceae, which are much less tolerant of direct sunlight. Altogether, 463 individuals comprising of 57 species were planted (See Appendix 1). Although herbs that normally live in cool and shaded habitats with damp soils are sensitive to light, many of them were able to withstand more intense light once they had adapted to the new conditions in the nursery. A list of collected plants that are sensitive to light is given in Table 1.

**Table 1: A list of plants that is sensitive to light**

Family	Species name	Local name
Taccaceae	<i>Tacca chantieri</i> Andre.	Beting
Begoniaceae	<i>Begonia</i> spp. (3 species)	Riang
Araceae	<i>Alocasia longiloba</i> 'lowii'	Keladi
Araceae	<i>Alocasia beccarii</i> Engl.	Keladi
Myrsinaceae	<i>Labisia pumila</i> Benth. & Hk.f.	Daun sangkoh
Hanguanaceae	<i>Hanguana malayana</i> (Jack) Merr.	Bakong
Araceae	<i>Piptospatha grabrowskii</i> Engl.	Sungkut ungkut
Araceae	<i>Aridarum</i> spp. (2 species)	Sungkut-ungkut
Palmae	<i>Pinanga rivularis</i> Becc.	Pinang raung
Zingiberaceae	<i>Globba atrosanguinea</i> Teysm. & Binn.	Lelemas
Zingiberaceae	<i>Boesenbergia</i> sp. nov.?	Cekur kampung
Zingiberaceae	<i>Boesenbergia burttiana</i> R.M. Smith	Jerangau
Zingiberaceae	<i>Haplochorema</i> sp.	
Selaginellaceae	<i>Selaginella</i> spp. (2 species)	Kaki hujan
Cyatheaceae	<i>Cyathea borneensis</i> Copel.	Paku lang
Flagellariaceae	<i>Flagellaria indica</i> L.	Wi buntak



The performance of more than 20 species of ornamentals as potted plants was also studied. The list of species selected, as given in Table 4, all possess attractive features like colours and shapes, and have market potential. The majority of these can be easily produced by vegetative propagation. The potted plants were displayed at the nursery office and Park Hq., and maintained by the local staff.

**Table 2: A list of plants selected for potting.**

Family	Species name	Local name
Araceae	<i>Homalomena sagittifolia</i> Jungh. ex Schott.	Kemuyang
Araceae	<i>Alocasia</i> sp.	Tipang ular
Taccaceae	<i>Tacca chantieri</i> Andre.	Beting
Palmae	<i>Calamus javensis</i> Bl.	Wi batu
Palmae	<i>Calamus laevigatus</i> J. Dransf.	Wi lia
Begoniaceae	<i>Begonia</i> spp. (3)	Riang
Acanthaceae	<i>Cosmianthemum magnifolium</i> Bremek	Bunga raja
Sapindaceae	<i>Lepisanthes amoena</i> (Hassk.) Radlk.	Gegamba
Palmae	<i>Daemonorops formicaria</i> Becc.	Wi bulu
Ophioglossaceae	<i>Helminthostachys zeylanica</i> L.	Tunjuk langit
Apocynaceae	<i>Alstonia angustiloba</i> Miq.	Pelai
Euphorbiaceae	Unidentified	Kelentit nyamuk
Liliaceae	<i>Dianella ensifolia</i> D.C.	Manang padi
Myrsinaceae	<i>Labisia pumila</i> Benth. & Hook. f.	Daun sangkoh
Gnetaceae	<i>Gnetum gnemon</i> Linn.	Sabong
Orchidaceae	<i>Coelogyne</i> spp. (2 species)	Orkid
Lecythidaceae	<i>Barringtonia lanceolata</i> (Ridl.)	Payens Putat
Palmae	<i>Pinanga rivularis</i> Becc.	Pinang raung

## 7.0 DISCUSSIONS

### 7.1 Species with Potential for Commercialisation

Species with low light tolerance include members of Araceae (e.g *Pipthospatha* spp., *Aglaonema rotundatum*, *Aridarum* sp., *Alocasia* spp.), and several species of Zingiberaceae, such as *Globba atrosanguinea*, *Boesenbergia* spp. and *Haplochorema* sp. They would be more suitable as indoor plants.

From the preliminary findings, 10 species have been found to possess potential for the mass production and commercialisation (Table 3).

**Table 3: A list of 10 plants with potential for commercialisation.**

Species name	Local name	Family
<i>Globba atrosanguinea</i> Hort	Lelemas	Small ginger with attractive red flowers. Propagation by suckers.
<i>Labisia pumila</i> Benth & Hook.f.	Daun sangkoh	Stemless, attractive herb with pinkish flowers and red round fruits. Propagation by suckers or seeds. Medicinal.
<i>Ficus deltoidea</i> Jack	Tangkai beritu	Epiphyte with obovate fan-shaped leaves and unique veins, easy propagation by cuttings. Medicinal.
<i>Alstonia angustiloba</i> Miq	Pelai	Beautiful tree form and branching pattern with whorled leaves. Good for potting; needs regular trimming. Medicinal.
<i>Barringtonia lanceolata</i> (Ridl.) Payens	Putat	Beautiful tree form, reddish young shoots.
<i>Helminsthostachys zeylanica</i> L.	Tunjuk langit	Medicinal and food plant; unique fronds and erect sporangium.
<i>Alocasia longiloba</i> "lowii"	Keladi	Attractive leaf shape, purple on lower surfaces. Medicinal.
<i>Alocasia</i> sp.	Tipang ular	Attractive stem and leaf shape. Easy propagation by seeds. Medicinal.

<i>Pinanga</i> sp.	Pinang muring	Attractive colour and form of the stem. Propagation by suckers or seeds.
<i>Pinanga rivularis</i> Becc	Pinang raung	Small palm with clustering habitat and fine leaves; suitable for indoors. Propagation by suckers.

## 7.2 Benefits to the Local Communities.

Generally, an increasing number of indigenous ornamental plants have gained interest among the local consumers lately. With proper growth, maintenance and care, herbs such as begonias and aroids can become popular indoor plants.

Owing to increasing popularity of decorative plants in the local markets, the local people have been encouraged to produce several suitable plants in plastic bags or pots for sale. These plants include *Pinanga rivularis*, *Dianella ensifolia*, *Helminthostachys zeylanica*, *Tacca chantieri*, *Alocasia* spp., *Begonia* spp. With the assistance of ITTO project officers, the plants can be taken to the Sunday markets in the nearby towns. With a little extra effort and a change in mindset, the local participants should be able to increase their cash income. It is necessary for them to forego their traditional lifestyle and switch to modern agro-based economic activities.

Some medicinal plants, for example Tangkai beritu (*Ficus deltoidea*), Paku manis (*Helminthostachys zeylanica*) and Kacip Fatimah (*Labisia pumila*), also possess the potential as ornamentals. For other less well-known medicinal plants, such as Sunti babi (*Thottea rhizantha*) and many others, more research is needed with respect to their uses and cultivation. At this stage, there is still no plan to commercialise these plants.

## 7.3 Demonstration Plot for Fruit Trees.

A total of 65 species of indigenous fruit trees were planted in a one-hectare plot beside the Lubang baya Ranger Station in 2002. Several of the more popular species included *Canarium odontophyllum* (Wernh.) Merr. (Dabai), *Dacryodes rostrata* (Bl.) H.J. Lam (Kemayau), Isau (*Dimocarpus longan* Leenh.), *Nephelium ramboutan-ake* (Pulasan) and Isu rian (*Durio graveolens* Becc.) There has been a steady demand for these local fruits in the local market.

With proper care and maintenance, many trees will bear fruits in the next few years, and become an added attraction for tourists. As part of the community-related activity, the local participants, with the support and assistance of the Park rangers, will be responsible for managing the plot at the end of the ITTO project. During the fruiting season, they can charge an entrance fee to tourists who wish to visit the orchard, and pick their own fruits. Value-added products such as drinks and jams can also be made from the fruits if necessary. Towards the end, this can help to encourage active community participation in economic activities and eco-tourism in BANP, while promoting sustainable utilization of natural resources.

## **8.0 CONCLUSIONS AND RECOMMENDATIONS**

A total of 172 species of plants were collected for the study. The materials obtained were in the form of seeds, seedlings, vegetative cuttings and suckers. The majority of them belong to the families Zingiberaceae, Palmae, Araceae, Begoniaceae, Gesneriaceae, Myrtaceae and Rubiaceae. From this number, 57 species were selected for trial planting in the mini garden, and more than 20 species were potted. Preliminary findings have shown that at least 10 species of ornamental plants possess the potential for mass production and commercialisation. Further studies are needed to learn more about their physiological requirements under cultured conditions, and mass propagation by vegetative means. It is important to make the local communities aware that acquiring supplies from the wild for commercial purposes is strictly discouraged.

This study covers only BANP and its surrounding areas. More plants of ornamental will be discovered if survey is extended to other areas and forest types. Records have shown that Borneo has more than 6,500 species of plants, including 3,500 species of trees, 290 species of palms, 2,000 species of orchids and 800 species of ferns and fern-allies. Sarawak is at the threshold of making concerted efforts to use the abundance of indigenous plant resources and traditional knowledge towards biotechnological advancement and there is still a lack of qualified, trained and knowledgeable expertise.

Problems encountered during study were:

1. The site selected for the establishment of the mini garden was sloppy with uneven terrain, making layout planning difficult. The clay soil was poor in nutrients. The site was meant to be a temporary one, pending the acquisition of a permanent piece of land where all the facilities and demonstration plots will be centralised.
2. Water supply to the nursery was difficult during the dry season, as the water had to be pumped into a tank from the river.

3. Interest and commitment of the local nursery staff were generally lacking, and needed constant supervision, which was not always possible as the research officer in-charge of the project was based in Kuching, and was also involved with other activities. The staff had been trained and should be able to work independently.

The following recommendations are made:

- Monitoring of the planted and potted materials must continue in order to gauge their growth and performance;
- Environmental parameters must be regularly and accurately taken in order to understand the growth requirements of the selected species;
- Trials on the use of potting mixtures and nutrients must be continue to obtain optimal results for the various species;
- Collect more information on the medicinal properties of certain selected species;
- Continue to encourage the local communities to develop an interest in ornamental plants as a way to improve their cash income;
- The Rangers must themselves be motivated, and together with the research officers, provide the lead in the collaborative effort to develop the biological resources of the Sanctuary and the Park in a sustainable and profitable way.



## REFERENCES

- Bibian M.D. & Chai, P.P.K., 2004. Floristic Survey of Batang Ai National Park. International Tropical Timber Organization (ITTO) & Forestry Department Sarawak.
- Chai, P.P.K., 1975. Ethnobotany, Part I. Sarawak Museum Journal 23 (No. 44 n.s.) 37-51
- Chai, P.P.K., 1978. Ethnobotany, Part II. Sarawak Museum Journal 26 (No. 47 n.s.) 243-270
- Chai, P.P.K., Lee, B. & Othman, I., 1989. Native Medicinal Plants of Sarawak. A Forest Department (No. FB 1). Forest Department Sarawak.
- Christensen, H., 2002. Ethnobotany of the Iban & Kelabit. A joint publication of Forest Department Sarawak, Malaysia; NEPCon, Denmark; and University of Aarhus, Denmark.
- Giles, K.L. & McLaughlin, M., 1997. The Commercialization of Biotechnology. In: Geneve, R.L., Preece, J.E. & Merkle, S.A. (Eds.) Biotechnology of Ornamental Plants. CAB International. 1 – 11
- Ivy S. A., 2004. Fish Resource Assessment Study of Lanjak Entimau Wildlife Sanctuary and Batang Ai National Park. International Tropical Timber Organisation (ITTO) & Forestry Department, Sarawak.
- Jabatan Pertanian Sarawak, 1988. Sayur-sayuran dan Buah-buahan Hutan Sarawak. Jabatan Pertanian, Sarawak.
- Kueh H.S., 2003. Indigenous Fruits of Sarawak. International Tropical Timber Organization (ITTO) & Forestry Department Sarawak.
- Pearce, K.G., Amen, V.L. & Jok, S., 1985. An Etnobotanical Study of an Iban Community of the Pantu Sub-district, Sri Aman, Div. 2, Sarawak. Sarawak Museum Journal Vol. XXXVII, No. 58:194-270.
- Van Steenis, C.G.S., 1958. Magic Plants of the Dayaks. Sarawak Museum Journal 8 (No. 11 n.s.) 432-436.

**Appendix 1: A list of plants tested in the mini garden.**

<b>Family</b>	<b>Species name</b>	<b>Local name</b>
Araceae	<i>Colocasia</i> sp.	Subung ai
Araceae	<i>Homalomena sagittifolia</i> Jungh. ex Schott.	Kemuyang
Araceae	<i>Lasia spinosa</i> Thw.	Bong
Araceae	<i>Pipthospatha grabowskii</i> Engl.	Sungkut ungkut
Araceae	<i>Aridarum</i> spp. (2 species)	Sungkut ungkut
Araceae	<i>Alocasia longiloba</i> 'lowii'	Keladi
Zingiberaceae	<i>Amomum</i> sp.	Lelemas
Zingiberaceae	<i>Hornstedtia reticulata</i> K. Schum.	Senggang
Zingiberaceae	<i>Zingiber</i> sp.	Ligun
Zingiberaceae	<i>Haplochorema</i> sp.	Cekur kampung
Zingiberaceae	<i>Etilingera fimbriobracteata</i> (K. Schum.) R.M. Smith.	Layun
Zingiberaceae	<i>Etilingera brevilabris</i> (Val.) R.M. Smith	
Zingiberaceae	<i>Etilingera rubromarginata</i> A.D Poulsen & J. Mood	
Zingiberaceae	<i>Zingiber pachysiphon</i> B.L. Burt. & R.M. Smith.	Munong
Zingiberaceae	<i>Alpinia glabra</i> Ridl.	Lemas bukit
Zingiberaceae	<i>Costus speciosus</i> Sm.	Pakbu
Orchidaceae	<i>Spathoglothis</i> spp. (2 species)	Orkid
Leguminosae	<i>Bauhinia</i> sp.	Panggal belut
Gnetaceae	<i>Gnetum raya</i> Markgraf	Akar tengang
Curcubitaceae	<i>Trichosanthes tricuspidata-bracteata</i> complex W.J. de Wilde	Akar emperekak
Leguminosae	<i>Spatholobus ferrugineus</i> (Zoll & Moritzi) Benth.	Akar kemedu

Dilleniaceae	<i>Tetracera</i> sp.	Akar kempelas
Vitaceae	<i>Ampelocissus cinnamomea</i> (Wall.) Planch.	Kerimpak pinggai
Myrsinaceae	<i>Labisia pumila</i> Benth. & Hook.f.	Daun sangkoh
Moraceae	<i>Ficus deltoidea</i> Jack	Tangkai beritu
Melastomataceae	<i>Melastoma malabatricum</i> Jack	Kemunting merah
Clusiaceae	<i>Garcinia</i> sp.	Kandis imut
Clusiaceae	<i>Mesua calophylloides</i> (Ridl.) Koesterm.	Mergasing
Flagellariaceae	<i>Flagellaria indica</i> L.	Wi buntak
Cyperaceae	<i>Mapinia cuspidata</i> (Miq.) Uitt.	Bejit
Acanthaceae	<i>Justicia gendarussa</i> Burm.f.	Kayu pakit
Cyatheaceae	<i>Cyathea borneensis</i> Copel	Paku lang
Marattiaceae	<i>Angiopteris evecta</i> (Forst.) Hoffm	Paku telinga gajah
Pityrogrammaceae	<i>Pityrogramma calomelanos</i> (L.) Link.	Paku embun
Rubiaceae	<i>Ixora laila</i> sp. nov.	Ixora
Musaceae	<i>Musa acuminata</i> Colla	Pisang lengki
Musaceae	<i>Musa suratii</i> Argent & A. Lamb.	Pisang kenyuai
Gnetaceae	<i>Gnetum gnemon</i> L.	Sabong
Myrtaceae	<i>Eugenia</i> sp.	Jambu hutan
Menispermaceae	<i>Pycnarrhena borneensis</i> Diels	Daun tubu
Arecaceae	<i>Iguanura curvata</i> R. Kiew	Pinang tudung pelanduk
Apocynaceae	<i>Alstonia angustiloba</i> Miq.	Pelai
Agavaceae	<i>Dracaena angustifolia</i> Roxb.	Sabang
Anacardiaceae	<i>Pentaspadon motleyi</i> Hook.f.	Empelajau
Myrtaceae	<i>Eugenia bankensis</i> (Hassk.) Backer	Ubah ribu
Rubiaceae	<i>Myrmeconuclea strigosa</i> (Korth.) Merr.	Mumban
Sapindaceae	<i>Pometia pinnata</i> Forst.	Kasai

Hanguanaceae	<i>Hanguana</i> sp.	Bakung
Orchidaceae	<i>Gramatophyllum speciosum</i> Bl.	Giant orchid
Araceae	<i>Amorphophallus campanulatus</i> Bl.	Maya
Arecaceae	<i>Caryota mitis</i> Herb.	Mudor
Marantaceae	<i>Phacelophrynium</i> sp.	Daun long
Dilleniaceae	<i>Dillenia beccariana</i> Martelli	Beringin
Leguminosae	<i>Cassia alata</i> L.	Enserugan
Blechnaceae	<i>Stenochlaena palustris</i> (Burm.) Bedd.	Miding
Nephrolepidaceae	<i>Nephrolepis biserrata</i> (Sw.) Schott.	Paku kubuk



Plate 1: Mist propagation shed with sand beds.



Plate 2: Shed-house with 1 layer of 35% light penetration.





Plate 3: Recording of relative air humidity under the shed-house.



Plate 4: A Small concrete pond built in the mini garden.





Plate 5: The sucker of a palm temporarily wrapped in leaves.

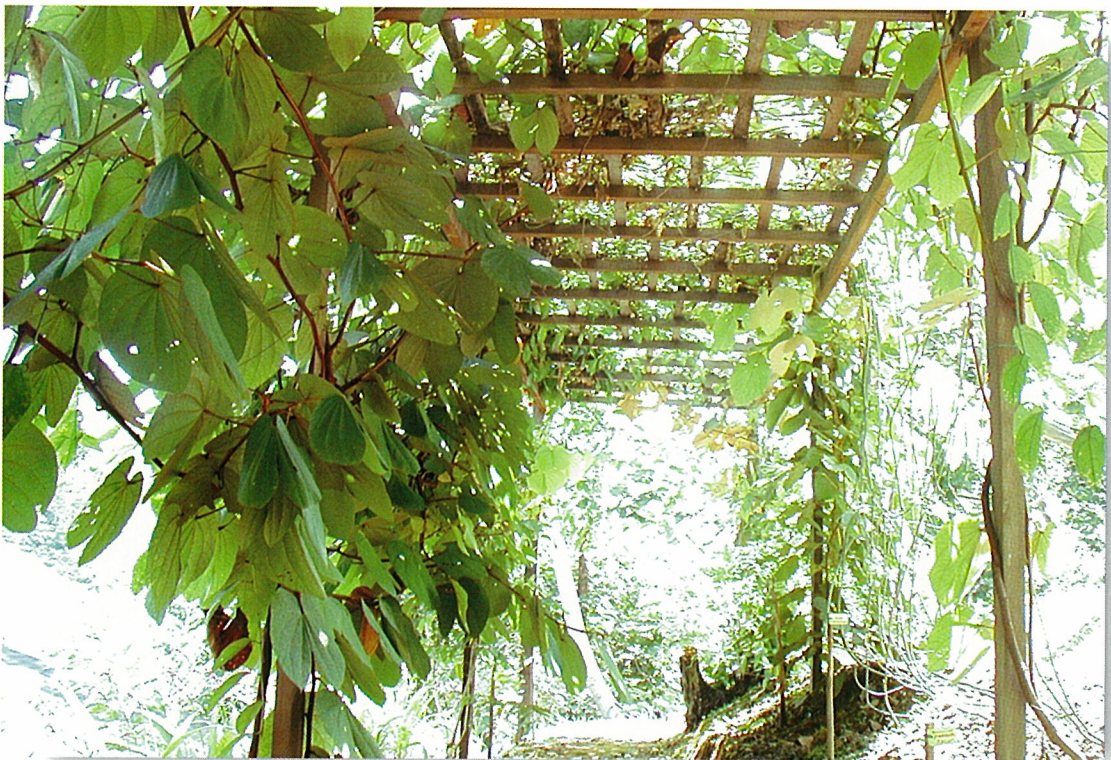


Plate 6: Climbing plants planted at the pergola.



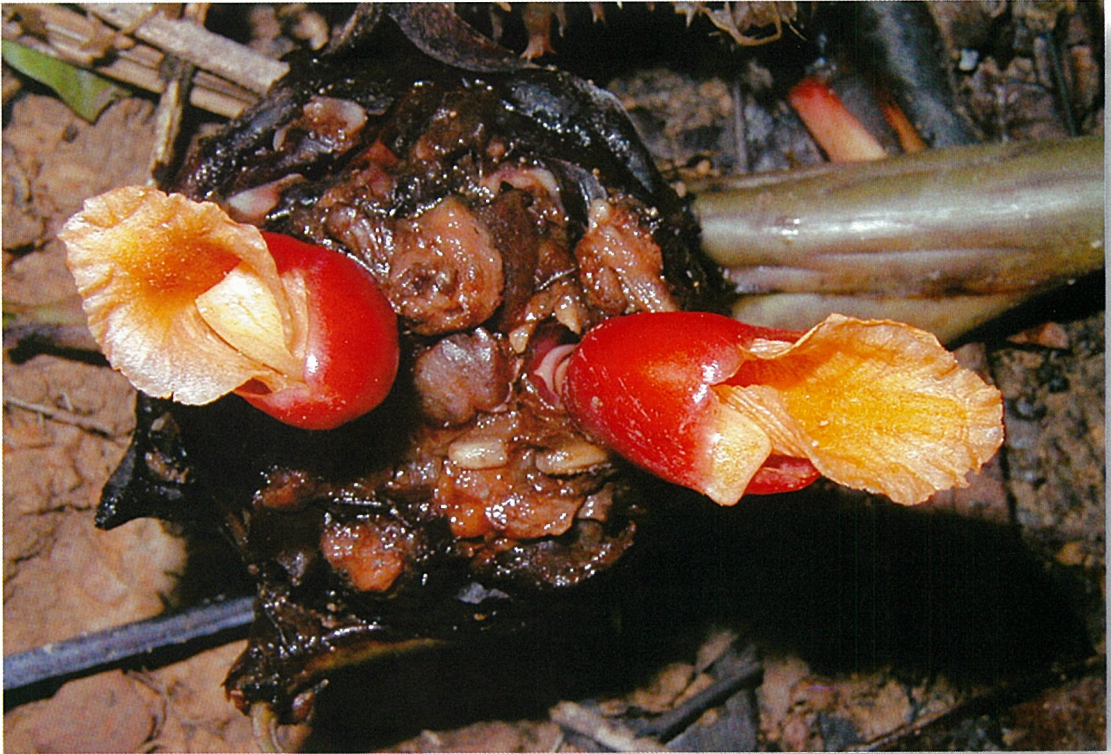


Plate 7: Flowers of *Costus globosus*



Plate 8: Medicinal herb, *Labisia pumila*





Plate 9: Another medicinal herb, *Ficus deltoidea*



Plate 10: *Begonia* sp.



