SCOPING STUDY ON CUTTING-EDGE TECHNOLOGY AND STRATEGIC KNOWLEDGE ON NTFPs FOR THE GREEN ECONOMY

Terminal Report

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EXECUTIVE SUMMARY

This paper reports on a study undertaken by the Non-Timber Forest Products Exchange Programme to scope out processed products and associated NTFP technologies in six ASEAN countries to determine what can be potentially shared across the region that are consistent with the emergence of a global green economy as well as prepare the NTFP sector for the impending economic integration in 2015. Technology interventions that lead to better utilization of NTFPs and consequently expand opportunities not only in improving incomes of forest-dependent resource gatherers but also contribute to the national economy through trade of value-added NTFPs were documented. Raising awareness on the possibilities for increasing returns from NTFPs through transformative yet sustainable technologies that yield commercially-viable products empower those who adopt them to make more decisions that are more favorable to them and the community to which they belong.

The six nations included in the country visits are Cambodia, Indonesia, Laos, Malaysia, Myanmar and the Philippines. There are a growing number of institutions in most countries, both government and non-government, that deal with NTFPs. NTFP-enterprises are also emerging for the commercial production of NTFPs, although interviews were made mostly with government and non-government organizations because of the reluctance among private owners of NTFP factories or processing plants to accommodate a foreign visitor. The region's rich biological diversity contributes to the range and variety of non-timber forest products that can be found in the different countries. The nature of NTFPs, namely bamboo, rattan, medicinal plants, resins, wild foods, honey, and natural dyes, and the motivation for their use are common across countries, although differences have been noted with regard to economic importance owing to endemicity of species, available volumes, marketability, demand in neighboring countries, traditional practices, and the state of technology for certain NTFPs. Traditional knowledge prevails in terms of how important NTFPs are identified, harvested, transported, stored, processed and consumed. Many NTFPs are traded in raw form, and

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in a number of cases, sold illegally across the border with adjoining countries. Technologies have been developed or are being adopted for some NTFPs that have reached commercial stage.

Models for cooperation to exchange information and technology on NTFP exist in the region. Except for these private-sector and non-government organization-initiated activities, little official interaction and cooperation occurs across countries that will lead to improved knowledge, utilization and bilateral trade on NTFPs. Specialized knowledge and expertise on particular NTFPs have been developed in several countries that can provide the foundation for establishing regional centers with the mandate to pursue NTFP database development, information exchange and capacity-building programs across the region. The establishment of a set of ASEAN experts group from different sectors representing government, communities, the private sector and non-government organizations dealing with various aspects of NTFPs is proposed to mobilize the development of such centers, as well as to intensify regional cooperation to eradicate illegal trade on NTFPs and attain a more holistic approach to achieving the goals of sustainably managed forests, equitable economic development, and an environmentally-secure ASEAN region.

SCOPING STUDY ON CUTTING-EDGE TECHNOLOGY AND STRATEGIC KNOWLEDGE ON NTFPs FOR THE GREEN ECONOMY

Introduction

This study was undertaken to scope out processed products from, and technologies using non-timber forest products (NTFPs) in selected countries in the ASEAN region in order to determine what can potentially be shared across countries that are consistent with the emergence of a global green economy. It draws inspiration from the Non-Timber Forest Products Exchange Program's (NTFP-EP) experience in linking resin gatherers in Cambodia to scientists in the Forest Products Research and Development Institute (FPRDI) in the Philippines that resulted in collaborative knowledge exchanges between the two countries, thereby helping expand livelihood and income opportunities for Cambodians engaged in resin tapping and collection. The study seeks to document interventions that lead to better utilization of NTFPs and consequently expand opportunities not only in improving incomes of forest-dependent resource gatherers but also contribute to the national economy through trade of value-added NTFPs.

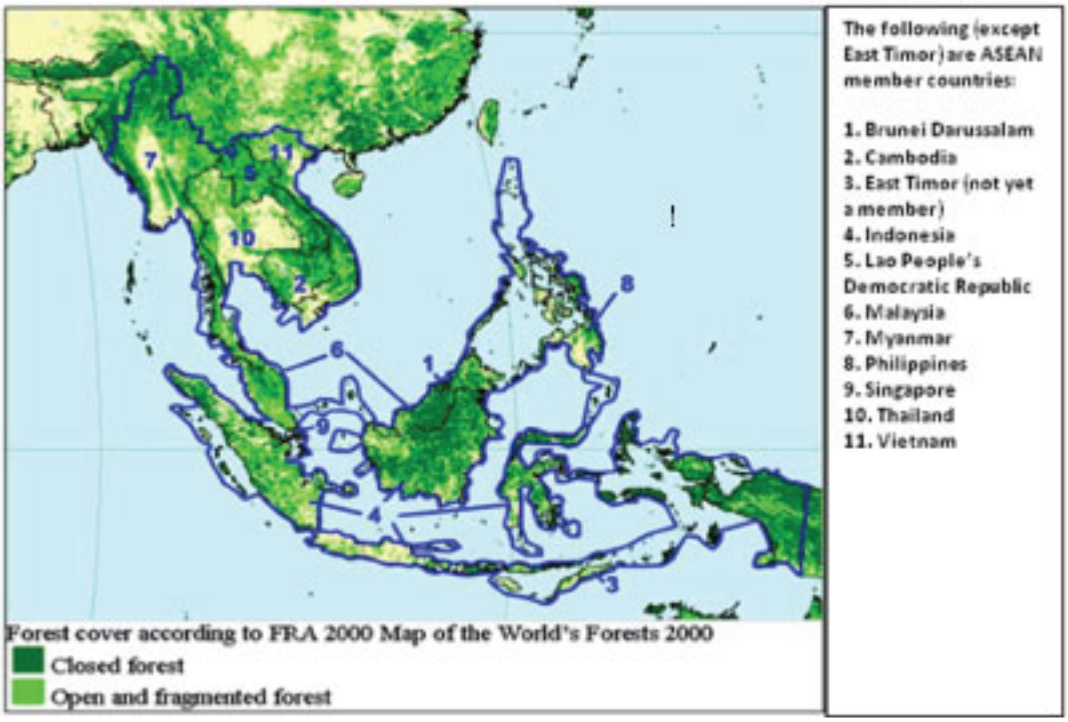


Figure 1. Map showing forest cover in Southeast Asia (Source:http://bioval.jrc.ec.europa.eu/products/veget_map_insulare- sea/images/sea_ins_fomap1.gif&imgrefurl)

The other motivation for the study is to prepare the NTFP-dependent sectors for the planned integration of ASEAN economies by 2015, with the ASEAN countries adopting a framework that will entail easing barriers to the trade of goods, labor, and investments. While such integration is anticipated to generally improve the standards of living and further increase the region's contribution to the global economy, it is uncertain whether the economically-disadvantaged people, such as the primary collectors of non-timber forest products, will be positively affected in the same way as the urban population in these countries. It is projected that the findings of the study will help prepare forest-based communities, in particular, and the ASEAN countries in general, to align forest-based economic activities towards meeting the demands of, and in realizing a bigger share of the benefits from an integrated economic bloc. By raising awareness on the different possibilities for increasing returns from NTFPs through technologies that can transform NTFPs into other, more commercially-acceptable products, people have more options that empower them to make decisions more favorable for themselves and the community to which they belong.

The study was undertaken through visits to different organizations and interviews with respondents knowledgeable about NTFP use in six different countries in the Southeast Asia Region, from October to December 2012. The countries were grouped into two: a) countries which are viewed as possible sources of developed NTFP technologies, namely Indonesia, Malaysia and the Philippines and b) countries that comprise potential NTFP technology recipients, which include Cambodia, Lao PDR, and Myanmar. This grouping stems from an understanding of the state of research and development efforts on NTFPs in these countries as well as the countries' degree of engagement in trade involving NTFPs. Due to limited time and the absence of contacts to facilitate arrangements for the visits and interviews, not all countries in the ASEAN regional bloc were covered.

Forestry Context in the Countries Visited

Features pertaining to land and forest area, population, and gross domestic product (GDP) in the six countries covered in the study are summarized in Table 1. Indonesia is first in all categories, except in regard to the proportion of forest to total land area where Laos ranked highest, followed by Malaysia and Cambodia. Myanmar, which has only a total land area that is almost a third of Indonesia, is the second biggest among the six countries. Myanmar's forest area is still close to half the total land area at 48.6%. Among the six countries, the Philippines has the least total forest cover although it is the fourth largest in total land area. The Philippines is next to Indonesia in terms of population but lags behind Indonesia and Malaysia in terms of GDP. These three countries have been deliberately classified as those which have NTFP technologies to share, while the three countries with relatively lower GDP, namely Cambodia, Lao PDR and Myanmar have been tagged as possible recipient countries.

In terms of the ratio of forest area to population, Lao PDR has the most forest per capita, at 2.4 hectares. However, in all the other countries, each hectare of forest has to support more than one (1) person. Population pressure is highest on the forest in the Philippines where each hectare has to provide for the needs of 12.5 people.

Table 1. Land, Population, GDP and Forest Area in the Six Countries Visited.

Country	Land Area, 2010 (1,000 Has)	Population, M Mid-2012[a]	GDP (USM$) 2010[b]	Forest Area, 2010[c]	
				1,000 ha	% of land area
Cambodia	17,652	15.0	11.26	10,094	57.2
Indonesia	181,157	241.0	708.37	94,432	52.1
Lao PDR	23,080	6.5	6.86	15,751	68.2
Malaysia	32,855	29.0	246.83	20,456	62.3
Myanmar	65,755	54.6	45.38	31,773	48.6
Philippines	29,817	96.2	199.59	7,665	25.7

[a]http://www.prb.org/pdf12/2012-population-data-sheet_eng.pdf

[b]http://knoema.com/atlas/ranks/GDP?gclid=CJjO8YKjiLUCFYp_6wodS0YAmg#

[c]2010 FAO Global Forest Resource Assessment

Incidentally, all six countries belong to the top 23 countries in the world considered as biodiversity hotspots (2011 Statistical Yearbook for Asia and the Pacific), among a total of 58 countries listed. Malaysia and Indonesia occupy the top two slots in that order, followed by the Philippines at no. 6, Myanmar at no. 14, Cambodia at no. 16, and Laos at no. 23. The remaining ASEAN member countries of Thailand (No. 8), Vietnam (No. 10), Singapore (No. 13) and Brunei (No. 18) are also in the list of countries where biodiversity is severely threatened. The biodiversity hot spots pertain to countries with the most number of threatened species. With species in Southeast Asia comprising 18% of all the species listed in the International Union of Conservation and Nature (IUCN), it is not hard to see why ASEAN countries are prominent in the biodiversity hotspots list. Hence, it is also important, amidst efforts to highlight the economic value of forests, particularly the NTFPs, amongst people who have traditionally benefited from them, that these economic activities do not unduly put pressure on the survival of biodiversity resources.

Major NTFPs

A summary list of the major and most common NTFPs in the countries visited is shown in Table 2. The list for each country was made following the interviews with various resource persons affiliated with research and development institutes, development organizations, forestry administrative/ regulatory agencies, some entrepreneurs, and leaders of forest-related NGOs in the region. A careful review of documents/reading materials (Appendix A) gathered during the visits was also done to reinforce the list.

Although the current list appears shorter as compared to that contained in the 2002 FAO report on NWFPs (Appendix Table C), the abbreviated list has actually benefited from better organization/ classification of NTFPs done in some of the countries, notably Laos. Three organizations in Laos, namely the National University of Lao PDR, the National Agriculture & Forestry Research Institute, and the SNV Netherlands Development Organization, collaborated to come up with the book "Non-

Timber Forest Products in the Lao PDR" which contains information on 100 commercial and traditional forest products. Noteworthy additions to the list of NTFPs in the region are *Corypha lecomtei* leaves in Cambodia, biofuels in Indonesia and the Philippines, scented wood and bark in Myanmar, and wild grapes for wine-making in Cambodia. The list from the Philippines was derived from the Philippine Forestry Statistics, an annual publication of forestry statistical information. This publication has maintained the inclusion of 13 different NTFPs in its list, although five NTFPs had zero or almost zero production in the last 10 years or so. These NTFPs had been excluded from Table 2, while biofuels and forest foods have been added to highlight the renewed interest in the importance of the forest in addressing these societal needs.

Table 2. Important NTFPs/categories of NTFPs in the ASEAN countries visited.

Cambodia	**Indonesia**	**Lao PDR**	**Malaysia**	**Myanmar**	**Philippines**
• Resin • Rattan • Bamboo poles & bamboo shoots •*Corypha lecomtei* leaves •Honey •Wild grapes for wine • Medicinal plants • Wild/forest foods	• Rattan • Bamboo • Resins • Essential oils •Honey • Fruits • Medicinal plants (Jamu) • Biofuels • Gaharu (*Aquilaria* wood) • Dyes	• Food • Medicine • Fibers (include bamboo and rattan) • Extracts • Ornamentals • Charcoal and fuelwood • Animal products	• Rattan • Bamboo • Medicinal plants • Wild food/fruits	• Bamboo • Rattan • Scented wood and bark • Gum, resin & oleoresin • Spice • Bast • Roofing material • Dyeing material • Medicinal plants	•Rattan • Bamboo • Palms (buri midribs, anahaw leaves, nipa shingles) •Vines • Exudates (almaciga and pili resins) • Biofuels • Forest foods • Honey

Institutions/Organizations Dealing with NTFPs

The six countries differ in terms of institutions and organizations dealing with NTFPs (Table 3). In the more developed countries, a good number of government agencies and forest research institutes take the lead in NTFP activities, along with the University and a handful of NGOs. In the Mekong River Basin countries however, along with government research institutes and academia, NGOs play a significant role in promoting NTFPs, many of which are engaged in developing livelihood opportunities based on NTFPs. There are also quite a number of international development organizations in Laos particularly and to some extent in Cambodia and Myanmar that focus on enabling forest-based communities realize better incomes from the forest and at the same time protect biodiversity. Quite expectedly, there are more intensive research activities on NTFPs in the academe in the more developed countries, where researchers are able to source external funds to undertake research, acquire laboratory equipment and testing apparatus, and support the thesis of students working on various aspects of NTFPs. In the less developed countries, focus is largely on instruction and curriculum development, with some research being done by students to meet academic requirements.

Table 3. Institutions/organizations engaged in NTFP work in the six countries visited.

Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines
Government • Forestry Administration Cambodia • National Cleaner Production Office-Cambodia, Ministry of Industry, Mines and Energy ***Academe*** • Royal University of Agriculture ***NGOs*** • Non-Timber Forest Products Exchange Programme • Rattan Association of Cambodia • Cambodia NTFP Dev't Organization ***Development Organizations*** •WWF-Cambodia • Volunteer Service Overseas	***Government*** • Ministry of Forestry •Forestry Research and Development Administration ***Academe*** • Bogor Agricultural University (Institut Pertanian Bogor) Faculty of Forestry ***NGO*** • Non-Timber Forest Products Exchange Programme – Indonesia Foundation (YPSDHI), WARSI, Crafts Kalimantan JMHI, Bamboo Foundation, Setara, YEI, KPSHK ***International Organizations*** • Center for International Forestry Research (CIFOR) • World Agroforesty Center (ICRAF)	***Government*** • Ministry of Agriculture and Forestry • Department of Forestry • Ministry of Industry and Commerce • National Agriculture and Forestry Research Institute ***Academe*** • Faculty of Forestry, National University of Laos ***NGOs*** • Enterprise and Dev't Consultants ***Development Organizations*** • SNV • WWF-Laos • Wildlife Conservation Society • RECOFTC-Laos • The Agro-Biodiversity Initiative	***Government*** •Forest Research Institute of Malaysia - Forest Products Div. - Natural Products Div. ***Academe*** • Universiti Putra Malaysia (Faculty of Forestry and Faculty of Economics and Management) and other state universities ***NGO*** • Non-Timber Forest Products Exchange Programme, Gerai Orang Asli, Elevyn	***Government*** • Forest Research Institute of Myanmar • Ministry of Environmental Conservation and Forestry ***Academe*** •University of Forestry, Myanmar ***NGOs*** • Ecodev • Network Activities Group • Food Security Working Group • METTA ***Development Organizations*** • DFID-SIDA	***Government*** •Ecosystems Research and Dev't Bureau •Fiber Industry Dev't Authority •Forest Management Bureau •Forest Products Research and Dev't Institute •Philippine Textile Research Institute •Cottage Industry Technology Center, Dept. of Trade and Industry ***Academe*** •University of the Philippines Los Baños and other state colleges and universities ***NGOs*** •Non-Timber Forest Products Task Force (a network 15 NGOs and peoples organizations in the Philippines working on NTFPs)

Technologies on NTFPs

The following discussion focuses on NTFP technologies that are available in the different countries visited, gleaned from the information generated from the forms (matrix) sent out and which were filled out by the organizations' representatives. The most number of responses received were from institutions mandated by the respective governments to undertake forestry research. The responses were consolidated by type of NTFP and the results are shown in matrix tables in Appendix **K**. The matrices describe technologies developed for the following NTFPs: bamboo, rattan, medicinal plants, dyes, plant fibers, and other miscellaneous technologies that can be used for several kinds of NTFPs such as handmade paper making, finishing spray booth, and collection methods. Some of the technologies listed in the matrices had been verified during the interviews with the heads or representatives of institutions where the technologies were developed. This presents one of the limitations of the current work, as in most cases and because of limited time, only the heads of the organizations were interviewed and not the actual developers of the technology who would have a better understanding of how the technology works.

The list of technologies in Appendix K includes those that had been presumably generated through years of research and development activities by scientists and experts in the different research institutes. We intended the matrix to contain, for the greater part, technologies that had been successfully adopted by end-users over time. Since the project scouts for technologies that can be shared across countries, it is important that they should already be undergoing farm/commercial application before their introduction for possible use by their ASEAN neighbors.

We presume, however, that what had been reported included all NTFP technologies developed, regardless of whether there had been uptake by the private sector. If a technology had been adopted, we had little way of knowing if it had been sustained over extended periods of time, or improved upon by the users of the technology. The itinerary for the study included only very few visits to actual operations and companies. In most of the countries, getting permission to enter the premises of private companies was difficult especially if the owners knew beforehand that a foreign visitor would be coming.

Most forestry research organizations cater their R&D efforts to develop technologies for uptake by entrepreneurs in the private sector. This is especially true for technologies that require the fabrication/purchase of process equipment and other inputs that entail expenditure of financial capital. Unfortunately, it is difficult to engage the private sector in interviews/documentation studies that would entail them to reveal their processes, even if the technology, partly or wholly, were adaptations from outputs of publicly-funded research. This highlights the need for patenting R&D innovations to insure that the institution that originated the technology continues to be recognized, and the developers fairly compensated for their work.

Apart from the NTFP technologies gathered from the written responses, the interviews also revealed information regarding on-going development and commercial activities on other NTFPs in various countries. Mentioned as important NTFPs are honey in Indonesia and Cambodia, Cambodian palm

(*Corypha lecomtei*) leaves exported for hat-making in Vietnam, Aquilaria wood in Malaysia, Indonesia and Myanmar, oleoresin and exudates in Cambodia and the Philippines, biofuels in Laos, Indonesia and the Philippines, forest food in Laos and the Philippines, and ornamentals (e.g., orchids) in Laos and Myanmar. Orchids are apparently being exported mainly to China, presumably not for their aesthetic value but largely for their medicinal value.

In many cases, exploitation and use of NTFPs are bereft of R&D and technology innovations, with cross-border sale of some NTFPs occurring sans legal documents and under the nose of authorities who receive payments to tolerate such “irregular” transactions. To quote an entrepreneur in Cambodia engaged in exporting NTFPs, “Why go through the difficult process of obtaining legal permits, when you end up paying the same unofficial fees even if you have all the papers?”

Before dwelling on the description of various NTFP technologies, it is important to define two related terminologies – technology and indigenous knowledge - as these terms also had to be clarified with respondents during the interviews. In the context of NTFPs, we defined technology as an activity or intervention that adds value to the resource, so that the primary producers and their community can receive a higher, more equitable share of the benefit that accrue from the commercial sale of the resource. A previous work on the subject (Hyman, 2003) defines technology as “as a critical factor in enterprise development,” which “includes equipment, tools, processes, products, materials, skills, and systems for converting inputs into outputs and distributing and using the outputs for consumption.” Thus, from a value chain perspective, technology will be any function in the chain that brings a non-timber forest product in such a form that makes them ready for immediate use and brings the product closer to consumers who will be willing to depart with their money to avail of the good or commodity derived from the NTFP. Hyman (2003) further added that the benefits to small-scale producers of being provided with technological assistance include increases in productivity, improvements in product quality, increased self-sufficiency, and development of local skills such as the capacity for further innovation, ability to enter new product lines and to create new possibilities for local manufacturing.

Indigenous knowledge, on the other hand, encompasses information that we learn about NTFPs in the course of their gathering, utilization and consumption by indigenous peoples and forest-dependent communities. The premise is that much of what modern society far removed from the forest know about NTFPs originated from IP groups and communities who are more familiar with the forests. The people who live within or close to the forest know which plants or plant parts can potentially be gathered with little harm to the forest ecosystem and subsequently, safely consumed for specific end-uses. We would never know that a particular plant is a cure for a given ailment, or that fruits are edible, or that a specific tool can be carved out from a vine, if we had not seen them first being tried, used, or consumed by the indigenous peoples. These bits and pieces of information are incorporated into technology that further improves upon the readiness for use, versatility, and accessibility of NTFPs to consumers. Defining these two terms in this manner sets the frame for addressing the issue of providing better rewards or payments to the primary gatherers of NTFPs, in exchange for their knowledge. Equally important, from a commercial standpoint, is the initiation by gatherers and producers of the value chains for NTFP goods that are subsequently brought closer to the consumers; unfortunately, the performance of this vital function is largely underrated in the distribution of margins and benefits from non-timber forest products value chains.

Bamboo

In general, all the respondents (except one) agree that bamboo is one of the most important NTFPs in their respective countries. This is reflected in the matrices received, where technologies on bamboo dominate the list of research and development (R&D) activities in the various research organizations within the six countries. The range of R&D activities is also wide, encompassing propagation and plantation development studies, product development, and analysis of bamboo supply/value chains. A listing of important bamboo species in the countries visited is shown in Appendix Table D.

There are two drivers of the current revival of research interest in bamboo: One, it is seen as a viable alternative to wood whose supply is diminishing in most of the countries due to declining forest cover and government policies that limit the harvesting of timber. Two, the global market for bamboo is expanding. China has dominated the international market for bamboo and bamboo-based products, which is expected to further increase to US$20B by 2015 (India Ministry of Agriculture). Most governments in the ASEAN have committed to promote bamboo as part of their contribution to sustainable forest development and conceivably as a means to meet increasing local demand for bamboo and to capture a share of the broadening export market.

Although naturally abundant in tropical Southeast Asian countries, bamboo plantations have to be and/or are being established to quickly reforest degraded forestlands and to supply the raw material requirements of enterprises looking to meet rising domestic and global demands. Hence, technologies have been developed to produce bamboo planting materials and for establishing bamboo plantations. Selecting local species and sourcing local materials for planting is critical in order to minimize adaptation problems associated with introducing new species of bamboo in the area to be developed. At the nursery, propagation of new bamboo planting stocks can be achieved through the use of one-node cuttings, selected from healthy mother clumps, then potting in plastic bags with media consisting of rice hull, chicken dung, compost and garden soil at 1:2 ratio, and then allowing the plant to root inside mist-propagating chambers. Dipping the lower end of the pole in rooting hormones before potting can stimulate root production. Field outplanting should be done at the onset of the rainy season.

Laos, the Philippines, and Vietnam are resorting to bamboo plantation development to address inadequacy in meeting current and potential needs for bamboo poles. China comes to mind as the model for such strategy, where bamboo plantation development lays emphasis on monoculture as the more economically profitable system of propagating bamboo. The success in the global market of engineered-bamboo products had transformed many bamboo production communities in China into prosperous villages. Thus, it is tempting for ASEAN member countries to adopt such a model. However, there is a need to put value on the possible loss of biodiversity and/or the depletion of soil nutrients under such a production system, among other potential adverse impacts. ASEAN countries can do well to try agroforestry systems that mix bamboo with vegetables, staples, fruit-bearing trees, other cash crops and indigenous forest species to prevent ecosystem losses associated with monoculture bamboo plantation development.

The harvesting of bamboo entails application of knowledge on the best age of the culm, timing (or season to cut), and proper techniques so as not to affect the productivity of the clump. PCARRD (1991) recommended a culm selection system that involves removal of over-mature, defective culms but leaving behind at least two to three fully grown, one-to-two year old culms for every young and developing shoot. Usable, mature culms should be cut in the dry season when no new shoot is emerging, and each pole should be cut as close to the ground as possible to maximize utilization of quality portions. Culms to be harvested should be uniformly distributed within the clump periphery. This leaves an even spacing among the residual culms and eventually of the new shoots that will emerge. In Indonesia, the recommended timing for the cutting of bamboo poles is during the months that do not contain the letter "r", as these correspond to the non-rainy months, which otherwise damage the harvested poles (Interview with Jatnika, 2012). Moreover, Jatnika added that within a day, harvesting has to be done after 12 noon, when the leaves are limp and the stems are relatively dryer, and never when there is full moon. Jatnika (2012) further claimed that scientific tests have verified the effectiveness of these traditional methods, and at the least in ensuring that the poles are relatively dry when they are severed from the clump.

Post-harvest treatment of bamboo is highly recommended and technologies have been developed to lengthen the use and service life of the poles. Preservative treatment methods that entail the use of chemicals are available, but these are seldom used, and are already considered detrimental to the reputation of bamboo as an eco-friendly material. Nevertheless, bamboo is extremely susceptible to decay-causing organisms and insect attacks that some kind of treatment is necessary to improve its resistance to deterioration. Non-chemical or traditional methods include soaking, curing, smoking and white washing but none of these provide long-term protection. In Indonesia, Yayasan Bambu has developed treatment methods that use a secret "herbal recipe" and/or the sequential soaking of the poles for two-week duration in water, vinegar, and ammonia, followed by drying. The more than 3,700 bamboo homes built in Malaysia, Germany, Abu Dhabi, Brunei and the USA with no complaints of deteriorating bamboo parts is a testimony to the effectiveness of Yayasan's treatment method. Figure 2 is a collection of photos showing some of the practices, materials employed as well as examples of products made by Yayasan in Bogor, Indonesia.

The use of bamboo poles in construction has been limited in the past by a major structural flaw – the pole is long and slender but generally hollow inside. This has restricted the use of bamboo to very low, and non-load bearing applications, lest it gives under much heavier weights. Nevertheless, developments in the technology for manufacturing engineered-bamboo products and the emergence of water-resistant adhesives with no harmful emissions are revolutionizing structural applications of bamboo. China is the global leader in the production and export of engineered bamboo flooring, paneling and related construction materials.

Drying of bamboo poles

Elevated bamboo house

Low-elevation bamboo house built by the trainees in Yayasan

Detail under the roof showing the manner in which the bamboo pole elements of the roof framework are connected with one another

Tying material used to connect bamboo elements in bamboo house construction; also another NTFP derived from the dried leaf sheaths of palms.

A series of handmade bamboo baskets with varying sizes.

Fig. 2. Some of the various practices, materials used, products made and prototype bamboo houses built by Yayasan in Bogor, Indonesia.

Adoption of the engineered-bamboo technology is being promoted in the Philippines. Similarly, Malaysia has embarked on engineering new products from bamboo that can replace wood, such as ”C-Bam” which can be used for construction formwork, as well as “Wood-V-Bam” and “MyScrim” Bamboo (high strand bamboo strips/splits that are compressed together), both of which can be used for furniture and construction. Commercial adoption of these products in Malaysia is slow and is not foreseen soon. The absence of commercial takers of these laboratory-developed products by processors and contractors in Malaysia can partly be attributed to the availability of lower cost but quality wood materials that can serve the same purposes.

The push for engineered-bamboo production in the Philippines has been formalized through the issuance of EO 879 by then President Gloria Macapagal-Arroyo, which mandated that 25% of public elementary and secondary school desks (prototype of school furniture are shown in Figure 3) should be made from engineered-bamboo. To accelerate the building of local capacity to meet these targets, the Dept. of Trade and Industry (DTI) introduced the establishment of a system of nodes and hubs, where nodes comprise of village- or community-level enterprises in bamboo-rich areas that serve as facilities for converting round poles into slats. The slats are then transported to the hubs where equipment and skills are available to transform the slats into engineered-bamboo planks, and then assembled into school desks in accordance with government-approved prototypes. This system markedly improves the supply chain of bamboo to be used as a raw material in a factory, as it affords gatherers upstream the opportunity to add value to bamboo and therefore, gain higher incomes from their produce. Transport efficiency is also improved, as only raw materials in usable form are loaded and delivered to the factory. This scheme leaves behind the rest of the pole that would end up being discarded as wastes downstream.

Fig. 3 (a) Arm chair and (b) school desk made from engineered-bamboo in the Philippines.

Other emerging technologies and uses of bamboo are its conversion to fuel pellets and to charcoal/ activated charcoal. Similarly, bamboo shoots are now being explored for new uses and FilBamboo is spearheading production of food products that contain small amount of processed bamboo shoots as an ingredient, e.g., bread muffins, native rice cakes, tea and coffee mixes, and also as herbal supplements.

There is an apparent disagreement in Malaysia on the assessment of the future potential of bamboo as an industrial material. While there seems to be fervent efforts at FRIM to develop new products and technologies to increase utilization of bamboo, the aspect of ensuring sustainability of supply has apparently been neglected. Bamboo is presumably getting scarce in Malaysia, such that bamboo components that are being used in the construction of mixed-media wood panel products have to be imported from China. Curiously, there are no serious efforts to establish bamboo plantations in the country. Thus, the gains in developing new products, which seems to be a priority focus project at FRIM, will be negated by the impending unavailability in the supply of materials. This calls for long-term joint visioning among the bamboo players in Malaysia to reconcile institutional/industrial/scientific aspirations pertinent to this important forest resource.

Rattan

Invariably, rattan conjures the use of the cane or stem for furniture, handicrafts, hand tools, and other household items, albeit other uses as food, tying material, thatch, wrapper of native delicacies and home-made cigars, and as medicine are also common for this palm. Trade in rattan cane and cane products have fluctuated widely for almost two decades already, as demand for furniture and other rattan crafts have been negatively influenced by the economic downturn in the global markets. The impact on rattan gatherers during periods of low global demand is severe in terms of lost income, but others see it as a mixed blessing as the lull provides the remaining rattans in the forest with the opportunity to "rest" and perhaps even regenerate during the period.

In reality, rattans are getting scarcer, evident in the fact that once rattan-densely covered forest areas in many parts of the Philippines, Cambodia, and Indonesia are virtually decimated. (Please refer to Appendix Table **E** for a listing of important rattan species in the countries visited). Rattan pole gatherers need to prolong their treks going into the forest and to return from a rattan-gathering mission. Unlike bamboo, there is far more serious threat to rattan populations because the repeated gathering of wild rattan canes adversely affects plant vigor or ramet[4] production and growth (Siebert, 2001). Thus, rattans have to be assisted to regenerate to replenish those removed through harvesting. Some research institutes in the region have responded to the challenge by developing technologies for propagating rattan through seeds, wildings, and suckers. Tissue culture techniques for raising planting stocks of rattan have also been developed in the lab and successfully applied in the field. Furthermore, procedures for raising rattans in plantations have been devised in order that they can be grown in reforestation areas or in second-growth forests. Not all technologies for rattan production are derived from scientific investigation. Indigenous peoples' groups in the Philippines help insure sustainability of rattan regeneration by harvesting poles only after fruiting and seeding, and only after new seedlings have begun to sprout (Guerrero, *pers. com*. 2013).

[4] Ramet pertains to an individual plant that has grown vegetatively from another individual as a clone of that plant, into a separate plant (http://davesgarden.com/guides/terms/go/2296/#b - April 9, 2013).

Rattan forests in the four villages of Ban Sopphouan, Ban Phonthong, Ban Phouangpatao, and Ban Donsat in Laos used to be under severe threats of disappearance, until the project engaged rattan-dependent communities in the sustainable management of their resource. The villagers were organized and participated in land-use delineations and resource inventory. Capacity-building in the preparation of forest management and harvesting plans were undertaken with no less than actual plans as outputs, which were then assessed and used as basis for their acceptance into the Forest Stewardship Council (FSC) – Lao Department of Forestry group certificate for sustainably managed forests. Harvested rattan poles are then delivered to a FSC chain-of-custody (COC) certified rattan products manufacturer. Designers assist the manufacturer in developing sustainable product designs, which entail minimal use of materials, lesser wastes and avoid the use of nails and screws for fastening. Examples of rattan products that were crafted using sustainable design and chain-of-custody principles are shown in Figure 4. Thus far, one container-full of products had been exported to Europe and a fraction of the sale would be set aside to sustain the cost of forest certification.

Certifying rattan forests, in a way, revolutionizes the process of gathering rattans for livelihood by linking the production system with a market that consciously demands sustainability of the products it consumes. Finding the FSC seal on the product provides consumers with such an assurance, but there is a price that must be paid by producers to earn this seal. FSC procedures and 3rd party certification are costly and often complex which cast doubt on the sustainability of this intervention. This is the reason why in Indonesia, the Participatory Guarantee System (PGS) is being pursued as the certification scheme and not 3rd party systems. This empowers the people and enables them to undergo certification of their production system at lower costs. Already, PGS has been successful when applied to agriculture products in a number of countries.

Figure 4. Rattan products made in Laos that employ sustainable design and follow chain-of-custody principles.

In Cambodia, the owner of a rattan products manufacturing company that hosted a plant visit for the study was a member of a team of fifteen delegates that went on an exposure trip on innovative rattan manufacturing practices in Vietnam. One of the technologies that he had learned from Vietnam which he now employs in his plant is a rattan treatment system that consists of an open treating tank where rattan poles are boiled in a mixture of 500 liters of water containing 15 liters of diesel oil. Before rattan poles are used for processing, they undergo sequential boiling-cooling in the tank with the water-oil mixture for 2 hours, ½ hour, and finally 1 hr, and then the treated poles are air-dried for at least two days. Waste wood and rattan trimmings are used as fuel to heat the tank. The oil-water mixture is recycled and reused in the treatment of several batches of rattan poles. The owner of the rattan furniture factory claimed to have performed rattan pole treatment trials where he replaced the diesel oil with vegetable oil, but the latter was not as effective as the diesel in protecting the rattan poles against the attack of decay-causing agents.

Fig. 5. Rattan treatment facility and rattan derivatizing machine adopted from Vietnam and used by a Cambodian rattan furniture maker.

The treatment system is just one of the rattan processing technologies that the manufacturer had learned from his trip to Vietnam. He was also able to purchase from Vietnam a machine that splits a rattan pole into several smaller strips that are more amenable to weaving (Figure 5). Woven parts made of small rattan strips with various creatively designed weaving patterns are the trademark of his rattan furniture. The first step for making every piece of furniture is to make the frame that will define the entire shape and size of the product. Weavers, mostly women, patiently lace each product with the desired pattern, and when weaving is completed, all parts of the furniture are smoothened before surface finish is applied.

The Cambodian Cleaner Production Office (CPCO) promotes the use of cleaner production technologies among enterprises in the country, including rattan technologies that were introduced from Vietnam. With funding from WWF and EU, five other technologies in addition to the rattan boiling technology were developed in Vietnam consistent with the principles of cleaner production techniques (Vietnam Cleaner Production Centre, *undated*). These other technologies include carbonization, bleaching, composting, solar drying, and dyeing of rattan. All of these are described in the manual entitled “Cleaner Production Techniques Guideline” for the rattan process and production sector. CPCO officials pointed out, however, that not all of the Vietnamese technologies are adaptable to conditions in Cambodia. For example, processors of rattan products still prefer to dry rattan poles under the sun because of abundant sunlight in the country as well as the dearth in high-caliber technicians in Cambodia who will maintain, operate and repair the drying equipment.

The foregoing brings to fore an important issue that is raised whenever technology, especially if it involves new process equipment, is introduced for adoption. The mere purchase or transfer of machinery does not complete the acquisition of technology. It is important that local capacity is built to run and maintain the machine properly in order that it would turn out the desired products in accordance with set specifications or standards. Know-how to maintain the equipment is essential so that it is kept in good running condition at all times. Finally, there is need for proficiency in diagnosing problems with the machine and in undertaking repair works whenever said equipment breaks down. Needless to say, cottage and small enterprises that include NTFP product-makers need support from all fronts, as the investment to adopt new technology, given the capital cost required and the associated capability-building requirements in acquiring new technology, would be relatively large given the scale of most enterprises in the region.

Cebu in the Philippines offers valuable lessons in terms of weathering slumps in global rattan furniture demand and the competition arising from China's relatively cheaper rattan furniture products. Furniture manufacturers in this central Visayan city in the Philippines have banded themselves into the Cebu Furniture Industries Federation (CFIF) and have since grown to account for 40% of the country's furniture exports. Cebu furniture companies have shifted to produce innovative high-end furniture designs, use mixed materials, and continuously train their workforce to become more skilled and improve the technology employed in furniture making and design. To further boost the city's reputation as the "Milan of Asia," the leaders of the furniture industry represented by Kenneth Cobonpue and Pete Delanter have committed to manufacturing furniture products based on eco-friendly designs that result in furnishings with benign impact on the planet. Their products employ alternative forest-based materials that are otherwise ignored, relieving the pressure on rattan and other materials whose supply has diminished because of the reduction in the country's forest area. Their strategy of "greening their supply chain" has enabled Cebu manufacturers to earn contracts with the very discriminating European furniture markets as they are able to conform with stringent standards such as the European Lifestyle of Health and Sustainability (LOHAS) (CFIF, 2012).

Medicinal plants

Under prevailing national accounting systems in Southeast Asia, there is gross undervaluation of the contribution of forests to human health. By and large, the tropical forests in this part of the world are still seen mainly as rich sources of good hardwood timber, while the fact that these same ecosystems are home to a mega-diverse range of plants and animals that can potentially provide the medicines for the healing and treatment of various human ailments has been overlooked. Unlike China and India which have maintained and even globally promoted their culture and tradition on the use of natural medicine, Southeast Asian countries, with the exception of Indonesia, are just beginning to look at how they can tap their vast biodiversity resources to address the health needs of their growing population. Important medicinal plant species in the different countries are shown in Appendix Table **F.**

Herbal medicine and drug discovery from plants form the focus of a well-funded, amply-equipped, R&D program composed of highly-trained pool of scientists at the Forest Research Institute in Malaysia (FRIM). FRIM has a natural products division that formulates and develops an array of plant-based health products, such as nutraceuticals, cosmeceuticals, essential oils and plant extracts, and disinfectants. Its roadmap for developing an herbal-based industry (Figure 6) seeks community participation in sharing traditional knowledge, provisioning of sustainable supply of raw materials, down to post-harvest facilities and product manufacture. Meanwhile, its R&D activities zero in on extracting, purifying, isolating and identifying plant-derived natural products that exhibit bioactivity against human diseases.

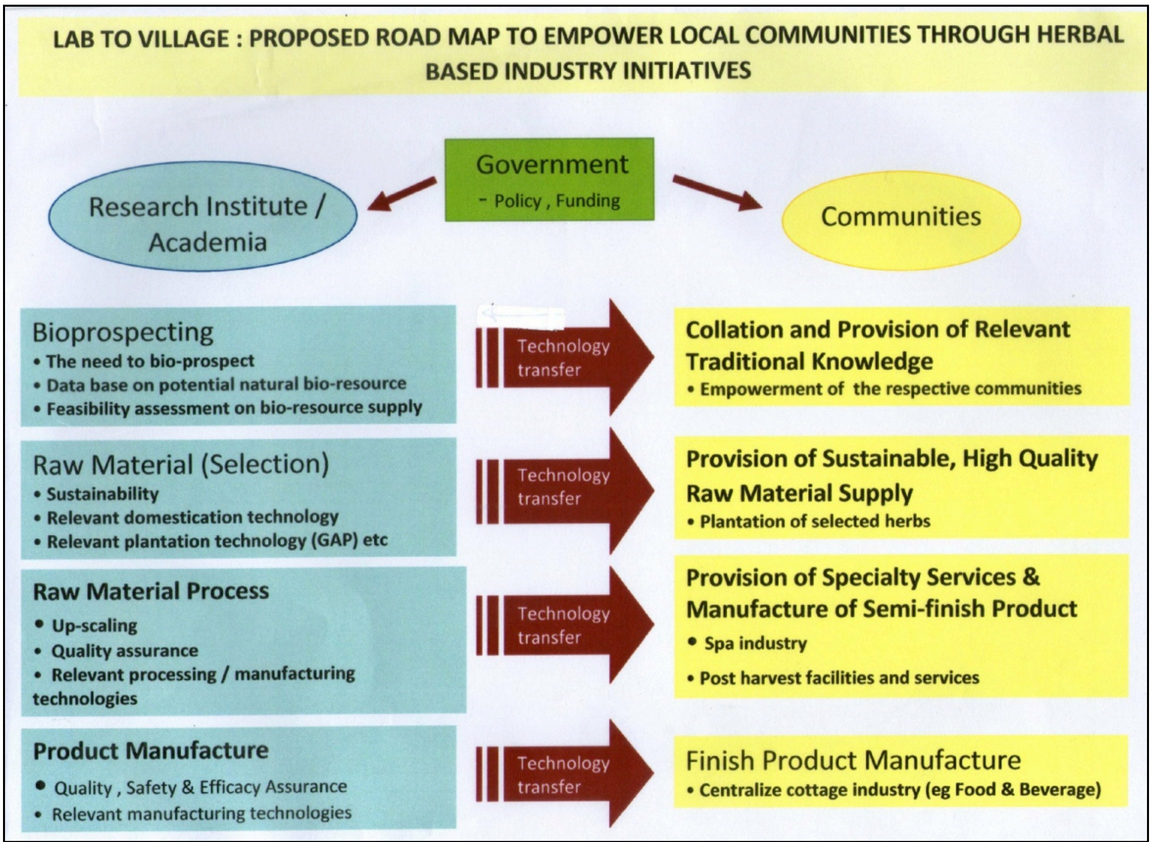


Fig 6. FRIM's road map for herbal industry development with community involvement (Courtesy of Dr. Mastura, Natural Products Division, FRIM).

FRIM also houses a modern, state-of-the-art facility called the Herbal Technology Centre, which is accessible for a fee, to the local herbal industry for the commercial production of herbal products. (Available equipment and process flow for herbal products processing at FRIM are shown in Appendix B). The Centre is divided into four sections as follows. The section on post-harvest technology maintains and operates equipment for oven drying and grinding of various plant parts that contain curative natural products. These materials can comprise of leaves, roots, flowers, bark, fruits or seeds from different plants, usually in air dried form before delivery to the Centre. The ground materials are then brought to the extraction section for the next important step of extracting the chemical compounds with water in an extractor or with screw press to squeeze the bioactive chemicals out of the plant parts. There are also jet mixers and homogenizers for combining extracts in accordance with a pre-formulated recipe. An evaporator, freeze dryer and spray dryer are also available to remove the moisture from the extract without degrading the active chemicals.

The next section is for milling and preparing the products in commercial form. The available equipment include a granulator, fluid bed dryer, particle size reducer, and double cone mixer for material preparation, tablet press and capsule filler to obtain the desired product form, and machines for counting and filling, blister and shrink packing, as well as for labeling. Finally, the quality control section provides services to test the quality and safety of the products, including detection of heavy metals, microbial load, and determination of stability and chemical markers. The local entrepreneur is also assisted in registering his or her product with the Ministry of Health Malaysia. Some of the herbal products developed and produced from the FRIM laboratory include capsules from Tongkat ali (*Eurycoma longifolia*) and Hempedu bumi (*Andrographis paniculata*), tea from Misai kucing (*Orthosiphon stamineus*), as well as essential oil and personal care products, and food seasoning items.

Indonesia is the Southeast Asian country with the longest history of using endemic, forest plants for medicinal purpose, and even has a name for this practice. *Jamu* is Indonesian term for traditional healing using plants, many of which have been reported to be effective against a variety of human ailments, such as the leaves of sour sop tree which can relieve gout and arthritis and inhibit the growth of human breast cancer cells, turmeric as cure for Alzheimer's, and a wide gamut of products such as slimming powders, appetite suppressors, and boosters of sexual performance (Neubauer, 2012).

Apart from the herbal products, Jamu is associated with regimens that contribute to wellness, such as aromatherapy and body massage. The Martha Tilaar group of companies, aside from producing color cosmetics and skincare, body care and hair care products, also operates hundreds of spa outlets all over Indonesia to provide well-being and beauty treatments along Eastern culture principles, including Jamu. The company also has a R&D group that explores the incorporation of natural products extracted from plants endemic to Indonesia into the company's product line of cosmetics and beauty products. In addition, a medicinal plant garden at the outskirts of Jakarta that showcases a collection of different endemic plants is maintained without the use of weedicide or herbicide. There is also a demonstration facility for making herbal medicine which can be used for visitor orientation briefings. These attractions have contributed to the popularity of the garden as an ecotourism destination where visitors can learn about the healing powers of nature and have a relaxing and enjoyable experience at the same time. Examples of medicinal plant preparations on display at the garden are shown in Figure 7 below.

Fig 7. Display of various medicinal plant preparations at the Institut Pertanian Bogor (top photos) and at the Martha Tilaar Organic and Medicinal Plant Garden (bottom three photos).

At the Institut Pertanian Bogor, members of the Faculty of Forestry engage in ethnobiology research that links the forests to human health. They have a collection of plant parts (ground or chipped form stored in sealed bottles or plastic bags also shown in Figure 7) as well as powdered and dried extracts that are on display in the laboratory and in a small store where they sell their products. They have developed a procedure for the chemical analysis of honey which is used to determine which product from among different sources is of the best quality. An enzyme preparation from honey is also being studied as a possible substitute for insulin in the treatment of diabetes. They are also currently identifying the structures of chemicals extracted from the heartwood of different tree species and conducting *in vitro* test to determine their effectiveness as cure for various human ailments. In the future, they expect to work with the IPB Faculty of Medicine for *in vivo* assays of their isolated compounds.

In the Philippines, the study on the medicinal value of different plants is largely done by the National Institute for Research on the Production of Medicinal Plants and the academe, particularly the University of the Philippines Manila, with the Philippine Council for Health Research and Development (PCHRD) as the R&D coordinating body under the Department of Science and Technology. Pascual Labs had successfully commercialized the production of Ascof® (cure for cough derived from the leaves of Lagundi (*Vitex negundo*) which is related to Molave (*Vitex parviflora*), one of the Philippines' most durable hardwoods. Having undergone clinical trials prior to its commercial release, Ascof® can be prescribed by medical doctors to their patients, unlike other herbal products which are considered as supplements and must contain the warning sign on the label, "With no clinically approved therapeutic claims."

In Myanmar, a medicinal plants garden is maintained in the campus of the Forest Research Institute Myanmar. Other than collecting and maintaining the plants, no further studies are being undertaken, especially to determine the bioactive chemical components responsible for the plants' curative effects. This presents an opportunity for cross-country collaboration, with Myanmar providing the candidate medicinal plant materials while the more advanced countries will undertake extraction, isolation, identification and testing of chemical compounds.

Aquilaria wood

Trees of the genera *Aquilaria* and *Gyrinops* are the sources of what is generally regarded as the world's most valuable incense. The trees belonging to the genus *Aquilaria* are distributed in several Southeast Asian countries, but because of exploitation to meet strong market demand, the species have already been included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Being in this category, trade of all parts and derivatives of the plant is supposed to be restricted. The high-priced wood, which is known by many names such as Gaharu, Agarwood, Aloes wood, and Eaglewood, is obtained by actually cutting the standing tree, with the best quality fetching as much as 3,100 US$ per kilogram.

The tree itself does not produce the resin. The wood has to be infected with a parasitic fungus to produce a rich, dark and aromatic resin within the heartwood. Different species of fungi have been screened for their effectiveness in inducing gaharu production. A collection of gaharu-inducing fungi is maintained at the Laboratory of Forest Microbiology at the Forest and Nature Conservation Research and Development Center (FNCRDC) of the Indonesian Forestry Research and Development Agency (FORDA). An inoculation method has been developed to infect the tree and accumulate the resin (See Figure 8). The improved technique involves the use of liquid preparation of the inoculants, which are then injected into several small holes distributed on the stem and branches of the living tree. However, it is important that the strain of the inoculants is compatible with the tree for induction to occur. Likewise, it was observed that the best timing for induction is after the tree produces its first fruits, which almost corresponds to the time when the tree reaches a diameter at breast height (dbh) of about 15 cm (FNCRDC, *undated*). This could mean waiting for at least 5 years from the time of planting for the trees to grow further before treatment. There are also studies on the optimum time (years following inoculation) to harvest the tree after induction, otherwise the wood will rot and low quality gaharu will be produced. Still, the best gaharu grade is derived from trees growing in the wild, where standing need not be artificially inoculated with the fungi in order to produce the resin.

Fig. 8. (a) Trunk of *Aquilaria* tree in Bogor, Indonesia bearing holes for inoculation of fungi that initiate resin formation; (b) Resin-rich Gaharu wood; (c) Some products containing resin extract from *Aquilaria.*

Aside from being used as incense in various traditional and religious ceremonies, gaharu wood (See Figure 8) is also used for treatment in health restoration ceremonies. The components of the wood are reportedly effective in treating various ailments affecting the stomach, kidneys, chest and abdomen, and also as a cure for asthma, cancer, and tumors. Agarwood oil can be distilled off from the wood and the distillate is reported to contain at least 31 chemical compounds, with methoxyphenyl ethyl chromone and phenylethyl chromone as the most dominant chemical species present. The oil is incorporated in a variety of products such as perfume, soap, essence, cosmetics, shampoo, pencil, whitening and massage cream, balms, etc. (FNCRDC, *undated*). Examples of products manufactured with Aquilaria oil as ingredient are shown in Figure 8.

Because of the endangered status of the species (*Aquilaria crassna* and *A. rostrata* are both listed as critically endangered species in the IUCN Red List of Threatened Species, 2012.2; all other *Aquilaria* species are listed as vulnerable), research has also been directed towards regeneration and conservation of the plant. While seedlings can be obtained through cuttings, it was found out that it was cheaper to propagate Gaharu by collecting wildlings under the mother trees and immediately transplanting them in plantations. There are now Gaharu plantations planted to *Aquilaria malaccencis*, *A. mycrocarpa*, *A. crassna* and *Gyrinops sp*. in Sumatra and Kalimantan which were established from seedlings directly taken from the field.

Growing *Aquilaria* in monoculture stands makes the tree susceptible to pest and diseases attacks, such as the larvae of the insect *Heortia vitessoides* which feed on the leaves of the tree. While chemical methods of control have been tried, this practice may not go well with the medical value of the plant. Practicing agroforestry (for cash crops such as corn and cassava that can provide for the farmers' needs while waiting for *the Aquilaria* to mature) and mixing *Aquilaria* with other trees such as *Azadirachta indica* can provide control measures compatible with the use of the tree.

Because of the nature of the source of the product which is the inner heartwood of a tree, and the manner by which it is obtained (that is, through cutting of the entire bole), the classification of *Aquilaria* as a non-wood or even non-timber forest product presents some definition problems. What is clear is its exclusion from the category "timber products" inasmuch as the extraction of the *Aquilaria* tree from the forest is not intended to produce industrial timber or wood. The premium value ascribed to *Aquilaria* is derived from knowledge about its cultural and traditional uses, which applies as well to most NTFPs that are gathered from the forest.

Palm (Corypha lecomtei) leaves

The production of *Corypha lecomtei* leaves is an NTFP activity that was observed in Cambodia. The visit to the Svay Cheas Commune, Svay Cheas Village, Snuol District, Kratie Province afforded the chance to see the operations of a cottage-level enterprise, purportedly the only one among four exporters to undertake the drying of *Corypha* leaves, before they are brought to the Cambodia-Vietnam border. About 20 to 30 families collect and supply leaves to this exporter. The leaves are gathered from the wild in low-elevation forests in the vast central plains of Cambodia, by cutting entire fronds at the rate of 2 leaves per "tree" per month. The collectors, some of whom come from as far as 10-20 km away from the location of the enterprise, are paid K170/kg ($0.04/kg) of their produce. Sometimes, a truck is on hand to pick up the leaves. But during the rice harvesting season, palm leaf collection is down.

Workers in the "factory" unbundle the delivered leaves, and then strike them one-by-one against a hard surface to force open each leaf. This is followed by manual separation to spread the pleated leaf apart before the leaves are hanged to dry. Men and women factory workers who are from outside the province, receive monthly wages of $90 and $75, respectively, and are given free meals; the higher pay for the men is presumably because they are the ones who carry around the weight of the material. Each leaf weighs about 7 kg fresh. Thirty (30) tons of young leaves brought to the factory would only weigh about 7-8 tons after drying and removal of rejects/wastes.

Drying is weather-dependent, and on good days, would take only 2-3 days to complete. If it rains on the first day, there is little damage done, but raining on the second or third day will be disastrous as the entire rained-down batch will become defective. In the dry season, 7-10 tons of leaves can be dried per day, although during rainy months, the output is much lower at only 3-5 tons per day. After sun-drying, the leaves are stored in a warehouse before being re-bundled for final sale. There is a machine that compresses about 70-80 kg of dried leaves apiece, perhaps the only mechanized activity done in the enterprise. The bundled leaves are then brought to the Vietnam border about 100 kms away from the factory. Delivery is made at least three times a month, with about 8 tons of dried leaves being shipped out each time. The processing of *C. lecomtei* leaves as undertaken in the factory in Svay Cheas commune is shown in Figure 9.

There exists an opportunity for collaboration with countries with more advanced drying technology to assist in this aspect of NTFP production that will enable Cambodian enterprises gain higher value and achieve faster turnover in the processing and trade of *Corypha* leaves. The throughput and quality of the dried leaves can be significantly improved if drying is done in a chamber where temperature, relative humidity and air circulation can be controlled. Experimental runs have to be done however to set up drying schedules that result in faster drying with no adverse effects on the quality of the dried leaves. The conduct of a feasibility study is imperative to determine if the investment in drying technology can be recouped over time. A reasonable return on investment is anticipated because the drying equipment can last for a long time and requires simple maintenance procedures. The waste leaves generated in the factory, currently disposed of by burning, can also provide the fuel for heating/producing the steam needed during the drying operation.

Figure 9. Steps in processing *Corypha lecomtei* leaves at the Svay Cheas Village in Cambodia.

The leaf, which is used for making the popular Vietnamese hat (*nón lá*) is both hard and light. It is leathery to touch and does not readily absorb moisture. At the same time, the leaf is impervious to liquid water. Some houses in Cambodia use the leaves for roof and for walling, and are preferred as housing components because the leaves are reported to be more resistant to fire than other natural materials. The midrib is reported to have other uses especially in Vietnam, although it is also being employed locally in Cambodia for ice cream sticks and basket making.

Incidentally, there are other applications of the *Corypha* leaves and for one such use, a small Moslem community in the province of Kratie benefits by stripping the leaves further into narrower sheaths. Each kilogram of previously-dried leaves can produce 400 grams of stripped fibers. The only tool needed is a piece of wood mounted with a blade against which dried leaves are individually pulled in one straight, uninterrupted arm movement by the operator. Twice a month, about 500 kg of the strips are transported to a storage facility in Phnom Penh, and then eventually shipped to Odong commune in Kampong province northwest of the city for final assembly into craft products. Midribs and waste leaves and strips are likewise sold for added income.

A listing of other important palms in the countries is shown in Appendix Table **G**. The range of uses for these palms includes food (source of sago, kaong, nuts, vegetable), stems, fibers, and materials for handcrafted products.

Honey

Honey is considered as one of the most important NTFPs in Cambodia and Indonesia (Please see Table 2), although the other countries, such as Malaysia, Myanmar, and the Philippines do have commercial honey production as well. The popularity of honey, particularly in Indonesia is possibly associated with the broad public acceptance of Jamu, which has no equivalent native practices in terms of scope, in the other Southeast Asian countries.

There are many tried technologies for production and processing of honey in Indonesia, and a distribution system is also in place with the creation and operation of the Indonesia Forest Honey Network (JMHI). Honey collectors and supporting NGOs from five of Indonesia's islands (Java, Kalimantan, Sulawesi, Sumatra and Sumbawa) comprise the network, whose main objectives are bee habitat conservation, promotion of the welfare of local bee collectors, and provision of a venue for sharing experiences in honey bee production among the members (Hermanto, 2011). Interventions that were made possible by organizing the collectors in a network have resulted in improved organizational management and business planning, better protection of forest areas where honey production is done, improved quality control, as well as acquisition of skills in marketing and promotion of honey.

However, honey production in Indonesia has been fluctuating widely, with production at record lows in 2012 followed by unusually high production of honey from Danau sentarum alone during the early part of 2013 (as told to C. Guerrero by Dian Niaga). Climate change is largely blamed for the unpredictability of honey production, and is allegedly aggravated by the massive conversion of forests to plantations as well as the widespread use of insecticides in agricultural farms. Contracts to supply honey to national retail outlets have been cancelled as honey bees have not returned to the forests to do their work. It behooves the honey sector in Indonesia to make a deeper study to verify the causes for the problem and implement strategies to stimulate sustainable wild honey production.

In Cambodia, wild honey production is an important NTFP enterprise in at least four provinces – Mondulkiri, Preah Vihear, Kratie and Koh Kung. The honey products are packaged together in a nice box made of native materials as a marketing strategy (See Figure 10). Imported honey products are competing with local honey, a problem which is being addressed by the social enterprise CEDAC (Centre d'Etude et de Développement Agricole Cambodgien). The NTFP-EP Cambodia through its marketing arm, NatureWild, provides assistance in sales promotion and marketing as well as in product development. NTFP-EP has also extended training to honey collectors on how to avoid the destruction of hives by not removing entire nests and by taking only the portion where honey is stored. CEDAC has local stores which serve as retail/ distribution outlets for honey that it buys from the communities. Buying honey from CEDAC stores also assures consumers that what they pay for is pure honey and not products adulterated with sugar.

Figure 10. A package of honey products from four different provinces in Cambodia.

Critical in ensuring the quality of honey is that its moisture should be kept at low levels to avoid fermentation. Acceptable methods of removing moisture from honey include proper ventilation and dehumidification. A short heat treatment inhibits fungal growth and retards crystallization of the honey inside sealed containers. However, prolonged exposure to high temperature, especially of honey in transit or during storage, can cause product deterioration. That is why it is best to transport honey at night when temperature is colder. Also, it is important to avoid mixing honey inside enclosed container cargoes that include odor-producing merchandise such as fish, as the smell can be absorbed by honey and consequently result in its rejection by potential buyers. A trader in Indonesia concedes that “honey production and trade is a very complicated business,” which is probably made more complex by the unprofessional attitude and practices of some people engaged in the business.

Recent research findings in Malaysia, Vietnam and Thailand have validated the health potentials of honey and related bee products. Clinical trials on the use of Tualang (*Koompassia excelsa*) honey produced by *Apies dorsata* for diabetic and burn wound dressing have shown positive results, with patients preferring the honey dressing in terms of cleansing, healing, reducing pain, inflammation, prevention of gauze adhering to the wound, and having a more pleasant smell (Sulaiman, 2012). The high phenolics and flavonoids content of Tualang honey explains its anti-oxidant activity, evident in its ability to reduce blood glucose levels in diabetic test rats and in reducing the blood pressure of spontaneously hypertensive rats (Sulaiman, *ibid.*). Preliminary *in vitro* culture tests for anti-proliferative effects against oral cancer cell lines and similar tests on other cancer cell lines have also shown the potential of Tualang honey to produce promising results. Almost the same findings have been found for the extracts from the propolis of stingless bee *Tetragonula leviceps* in Thailand, where anti-proliferative activity against five cancer cell lines of colon, stomach, lung, hepatic and breast cancer have been demonstrated (Chanchao, 2012). In Vietnam, on the other hand, the composition of bee pollen has been found to contain 7-35% proteins, 5% sugars, a dozen of vitamins (e.g., B-vitamins, Vitamins A, C, D, E and a host of phytochemicals), as well as minerals and hundreds of enzymes and co-enzymes, fatty acids and various growth regulators (Chinh & Trung, 2012).

Resins and exudates

There are many types of resin and exudates products from Southeast Asian countries, depending on the most widely available resin-producing trees and the culture and traditions that were built in the community relative to harvesting and using these natural products. (Appendix Table **H** shows a list of important plant species that produce resins, exudates and scented wood). Indonesia is the world's largest supplier of gum resin from *Agathis* trees and of dammar obtained from dipterocarp tree species. The Philippines contributes Manila elemi from *Canarium* species to the global resin trade, including some almaciga (*Agathis philippinensis*) gum resin (also known as Manila copal), primarily from the island province of Palawan and to some extent, Samar. Commercial pine resin is also obtained by tapping stems of the widely distributed *Pinus kesiya* trees in the Mekong countries including Vietnam and Thailand, and in the distant past, from trees in the highlands of the Mountain Provinces in Northern Philippines. Cambodia's share is in the form of oleoresin or balsam from *Dipterocarpus alatus* and *D. intricatus* trees.

An output of a project funded by the International Tropical Timber Organization (ITTO) resulted in the fabrication of specialized machines and the construction of a pilot plant (Figure 11) designed to refine Manila copal, the oleoresin exuded by Almaciga (*Agathis philippinensis*), a tropical softwood tree species. A private entrepreneur adopted the pilot plant, but this has not been operated commercially because of problems with procurement of raw almaciga resin.

The trees in Cambodia that are tapped for oleoresin have a characteristic hole on the stem that is black in color due to burning. The hole is made through transverse cuts to reach the sapwood portion of the trunk, forming a cavity directed downward in order to allow accumulation of the resin inside. The width, height, and depth of the hole depend on the tree size, with a limit of at least 50 cm dbh in order to prevent the tapping of immature trees. In general, only one hole is made per tree, and no other hole can be made unless the previous one has stopped producing resin and has fully recovered, which usually takes about 4-5 years. Burning to stimulate resin exudation is a commonly accepted practice, but only for a very short period so as not to damage the tree and to prevent the fire from spreading to the surrounding vegetation. Baird (2009) claims that while the burnt, black hole on the tree may be ugly to look at, which makes some people think that it is damaged and in danger of dying, these "holed" trees are probably assured of much longer existence than dipterocarp trees in forest zones that are not being tapped. Realizing that the trees can substantially augment their cash incomes, which can be as high as US$250 per tapper during peak collection months, the "owners" tend to be more protective of their trees compared to the orphan trees with no tapper-claimants.

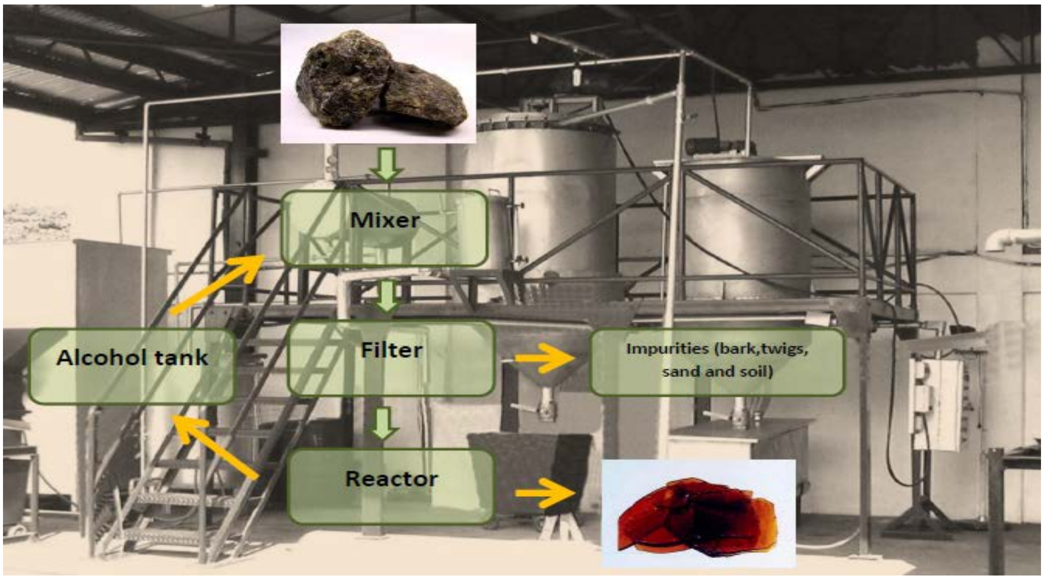


Fig. 11. Pilot plant for refining *Almaciga* resin (Manila copal) including equipment fabricated by FPRDI scientists and engineers for an ITTO-funded project, Philippines.

The chemical composition of Dipterocarp oleoresin from Preah Vihear province was determined in the FPRDI laboratory in the Philippines to serve as basis for determining possible end-uses of the product. The results sparked strong interest among decision-makers in Cambodia to rethink development programs *vis a vis* the forest, especially in relation to government efforts to address poverty in rural areas in the country (Pinto, *personal communication*). A foreign investor with a social agenda has also embarked on trading of dipterocarp oleoresin, with the end in view of lessening the gatherers' dependence upon big traders who control the business. Part of the strategy is the creation of a community business organization (CBO) that will buy at a price higher than market (big traders') price, and then siphoning portions of the CBO's profits back for monitoring to insure that tapping is done properly as well as for replanting trees and protecting the forest. The farmers will also undergo training on proper tapping and collection techniques, the use of appropriate container to avoid deterioration of the resin during transport, and also on managing inventory and cash flow.

Wild plant foods

Up until humans practiced farming, they relied on the forests for all of their basic needs, especially food. The emergence of agriculture supplanted forest food sources as farms assured reliability and adequacy of supply, gradually lessening dependence on the forest for subsistence for the great majority of the world's population (Zvelebil & Pluciennik, 2002). But now, people are returning to the forest for food not just to supplement quantity but for nutritive quality as well, and the rate at which this is happening in Southeast Asian countries is influenced by many factors such as the country's population, area of remaining forests, hunger and/or craving for diet diversity, shortage of "market-supplied" foods, and the country's state of economic development. Appendix Table **I** shows the wild plant foods that are gathered/utilized in the six ASEAN countries.

Among the countries visited, Laos appears to lead in consumption of vegetables (mainly leaves) derived from the forest, and these vegetables even form part of regular fare served in many restaurants offering local recipes. The country's long period of war also contributed to the greater familiarity of the Lao people with various edible plants from the forest. Foppes and Ketphanh (2004) recorded more than 700 plant and animal species that form part of the diet of the Lao people.

Fig. 12. Forest food plants served in a popular local food fare restaurant in the heart of Vientiane, Laos.

On the other hand, the non-forest dependent populations in Malaysia and the Philippines have very limited access to foods sourced from the forest, except for those that have been commercialized (e.g., canned fruit jams by the Ikalahans in Nueva Vizcaya) as a means of livelihood by forest-based communities. Popular as leafy vegetables in these two countries are the young fronds of fern (*Stenochlaena sp*.) and there is a good number of edible tropical fruits that are already mostly cultivated and commercially sold (FAO, 2000). In Myanmar, the forest provides spices such as cardamom, black and long pepper and *Cinnamomum sp*. that go into household cooking in the rural areas or for cash income. Mushrooms, which are largely collected freely from the forest, are quite popular in Laos, Cambodia and also in Myanmar. Bamboo shoots from species native to the country are commonly eaten in Laos, Cambodia, Myanmar while in the Philippines, bamboo shoots are blended in herbal tea, cakes, desserts, and native delicacies already made available in the market. In Indonesia, illipe nut oil for cooking, as well as for medicine and a variety of uses is popular although production is largely exported. The grave threat to illipe nut production is the fact that it is derived from trees of *Shorea spp*. which are very important commercial timber species. A recently completed study assessing wild foods in Cambodia has shown that wild food availability and traditional knowledge on their preparation are decreasing. The study also documented the sources and methods in which wild food are collected, the different recipes that use these wild foods, and the loss in natural flavoring because of the use of synthetic condiments (such as MSG). The study recommended the development of new agrosystem models, better management of forests, and wild food domestication as a means to promote the use and encourage the conservation of wild food sources.

Technology plays a role in determining the degree with which wild foods are availed of by both forest dwellers and by the general population, and vice versa. If knowledge exists on the planting, cultivation, harvesting, storage and "cooking" of wild foods, their availability and consumption increase, and surpluses in production even become the basis for livelihood (e.g., selling, processing and canning) for forest communities. Conversely, when information spreads on the beneficial medicinal and nutritional value of certain forest foods, their popularity (and market demand) rises and soon, these foods become the object of intensive gathering that endangers their very survival. It will be fortunate if propagation, harvesting and conservation methods are established before the population of such species becomes severely threatened. Additionally, the conversion of forests diminishes the availability of many such valuable forest foods. In the long term, there is danger of losing indigenous knowledge on the food value of threatened forest species unless more attention is paid to education and information campaign efforts that encompass proper identification, appropriate methods of harvesting, storage and preparation, as well as the nutritional and other benefits of these alternative food sources.

Natural plant dyes

Dyes from natural plant sources had been used for a long time as cosmetic to paint human skin and color household accessories such as cooking utensils and home furnishings, but the largest use was reserved for textile fibers that go into human clothing. Knowledge and craftsmanship in the use of natural plant dyes for coloring fibers that were used for clothing and for bags, hats, mats, and other accessories and decorative fixtures developed in several Asian countries, such as the makers of batik in Indonesia, silk cloth in Cambodia, and abaca fibers (T'nalak) among indigenous tribes (e.g., Tboli) in the Philippines. In Indonesia, specialization and sophistication in batik-making skills in different regions have even evolved, that one can tell the plant source, the technique used for extraction of the dye, and the dominant color imparted, of the different regions (Widiawati, 2009). Appendix Table **J** shows some of the plants in the six ASEAN countries that serve as sources of dyes used for coloring fabrics, among other applications.

But the invention of synthetic dyes that were a lot easier to handle, more convenient and faster to use, and which provided more uniformity and longer-term stability (color fastness) of the dyed product, eroded preference for use of natural plant dyes (Widiawati, 2009), even in batik making. In addition, natural dye sources have dwindled due to the destruction of forests. The replacement of natural dyes with synthetics has also brought in some cultural change in the practice of batik making, long confined to women using natural dyes to stain natural fibers, to men engaging in dyeing textiles and fibers with the artificial colorants.

The restoration of market preference for naturally dyed fabrics and baskets has revived interest in the use of plants as sources of dyes. The JMM cooperative in Sintang in Indonesia has even gone into the planting of dye-producing plants such as Morinda and Jerenang (*Daemonorops*), the source of dragon's blood, to beef up supply of natural dye sources. Other developments that have taken place include increased search for additional plant sources, improved extraction and application processes, and formulation of environmentally-conscious marketing messages for a growing pool of customers of products using natural dyes. According to Widiawati (2009), even the apparent disadvantage of non-uniformity and inconsistency in the color of several fabrics that turn out to be marginally different from the others despite "being dyed in the same way using the same material," can be transformed into a marketing advantage because in fashion, each one wants to be unique from everybody else.

A number of technologies had been developed by the Philippine Textile Research Institute (PTRI) to enhance the use of natural dyes (Please refer to Appendix Table D). They have claimed to have developed environmentally-friendly extraction processes from different plant sources that yield a variety of colors when applied to different types of fibers, yarns, and fabrics. Crude extracts can also be converted into dye powder, which render the advantages of having dye products that have longer shelf-life, convenient to transport, and which can be employed to a broad range of applications. The dye can also be formulated into printing paste that can be applied directly to fabric or already manufactured garments through silk screen printing. A number of equipment for crude dye extraction, powderizing, and dye application to the fibers have also been developed/fabricated, some of which have been already adopted by small-scale, handloom weavers in the Philippines.

Issues in the Development of Technologies for NTFPs

Paucity of research on NTFPs

Improving livelihoods based on NTFPs and the advancement of enterprises that use NTFPs as raw materials depend, to a large extent, on the quality and number of research and development activities being undertaken on these resources. Technologies that stem from R&D lead to lower cost of inputs, reduced wastes, more efficient machines, faster turnover, and products with more consistent quality. Technology affords products that are compliant to standards that consumers want in items they buy. Unfortunately, R&D activities on NTFPs in most countries in Southeast Asia are quite limited. Forest research institutes and even the academe are generally focused on implementing research on timber and timber products. Only about 10% of the total research activities in these organizations are on NTFPs and correspondingly, little research funds are allocated for such purposes.

Likewise, R&D institutions lack the skill and expertise to undertake scientific research on NTFPs. While specialization on various facets of timber and timber products are available, e.g., Tree Physiology, Timber Harvesting, Wood Physics, Chemistry, and Anatomy, Timber Mechanics, etc., there are no such specializations for NTFPs. Books and library resources in forestry, despite covering wide-ranging grounds, mention little about NTFPs and are mostly centered on timber. Expertise in NTFPs are generally developed as extensions of what scientists do in their respective fields, e.g., an expert on tree pests and diseases may also delve on the pests and diseases of NTFPs. Considering the range and diversity of NTFPs, this expertise by extension may not be adequate to address the whole gamut of technological problems associated with regenerating, managing, conserving and utilizing NTFPs.

In general, NTFP research in the ASEAN is done by government research institutes and the academe. There have been little inputs from, and uptake by, the private sector of NTFP research outputs. Perhaps, the relatively low returns from NTFPs compared with timber, among others, have kept entrepreneurs away from businesses associated with NTFPs. The rise of green economy is anticipated to bring about a reversal on this as NTFPs can serve the green economy model better than timber products.

What NTFP technologies to develop?

Given the lack of familiarity by many R&D organizations with NTFPs because of their preoccupation with timber, scientists are confronted with the question, "What R&D work on NTFPs to do?" In view of the limited support for NTFP R&D and the misconception that return on investment (ROI) for NTFP research is lower than that for timber, scientists have been constrained in coming up with innovative ideas for better processing and utilization of NTFPs. Consequently, experts confine themselves to doing research on NTFPs that follow tried-and-tested models or frameworks for timber, resulting in outputs that do not necessarily fill gaps in knowledge about NTFPs. Some NGOs in Myanmar, for example, have complained that they have difficulty working with the research organizations in the country because the R&D outputs on NTFPs of the latter do not suit the needs of the communities and clients that the NGOs serve. It should be noted that most NGOs that provide assistance to communities engage in, among others, developing and promoting livelihoods based on resources that are accessible to the community, which for the most part include NTFPs.

Thus, it is important for research organizations to reflect on their ability to interface with NGOs and to interact with communities to find out how their research can be made more relevant to the needs of these new clients. This can be a very rewarding exercise for the research institutions as the insights to be gained from such encounters can contribute to identifying researchable areas and in generating novel ideas on the best approach to solve particular problems. Even more challenging to the R&D organizations is taking that first step to reach out to the communities and villages to discover what needs can be met through technology development. Unlike timber companies, the communities, indigenous people's groups and some development-oriented NGOs do not have the resources to consult with experts in R&D organizations. It is about time for forest research institutions to step out of their ivory towers and get a better feel of the problems faced by marginalized communities.

Sustainability of NTFPs

Are there enough NTFPs to justify developing technologies for them? This is one question that propped up in the course of the interviews, and is also considered to be one of the reasons why little attention is paid in some countries to R&D that leads to the development of new NTFP technologies.

Indeed, what good will the technology bring when the resource that will use the technology is being depleted at unsustainable rates?

The lack of benchmark information on the availability of NTFPs in most of the countries makes it difficult to aptly respond to such concerns. Inventory data on NTFP resources are lacking, and wherever they may be found, the information only covers one or two NTFP resources in a few, selected areas. There is also the problem associated with the method to use in order to assess with confidence how much NTFP is available in an area, and for that matter, in the entire country, to determine if the resource is adequate to support the emergence of a NTFP-based industry.

It is also necessary to reflect on the threats to the sustainability of a given NTFP. Is the NTFP threatened due to over-exploitation for lack of better techniques? Do gatherers understand the adverse impact of over-harvesting a resource? Or is the NTFP being removed without replacement because the users do not how the resource can be regenerated? Is it also possible that the presence of NTFP competes with other economic objectives on the land, for example, the planting of cash crops? Under a situation where appropriate incentives are in place, and when both the community and the private entrepreneur are both responsive and responsible, it is our view that technology that creates more added value will be able to contribute to the long-term sustainability of NTFPs.

Alongside the development of value-adding NTFP technologies is the imperative to actually expand the NTFP resource base through the intensification of their replanting not only for economic reasons but also to meet environmental and biodiversity conservation objectives as well. Current efforts at reforestation in the Philippines, which has embarked on the very ambitious National Greening Program (NGP), as well as similar efforts in Indonesia with its One Billion Trees Program, among other countries, afford an opportunity to pursue planting programs that include NTFPs. Already, bamboo and rattan are included among the species to be planted under NGP in the Philippines, but the inclusion of other NTFPs will be more beneficial in terms of forest diversity renewal and restoration. It is important for ASEAN countries to learn from each other in their conduct of their reforestation programs, incorporate NTFPs among the species being planted as has been done by the Philippines in its NGP, and to disseminate widely the information that such efforts are being undertaken in order to engender much broader and grassroots-based, people participation in these programs.

The role of policy

In general, NTFPs take a back stage to timber resources when it comes to government policies pertaining to the forest and its management. Even the grant of forest management and/or community-based agreements and similar instruments to qualified land tenure applicants is premised on the assumption that the recipient will eventually access the growing trees in order to economically benefit from them. Harvesting the NTFPs is mostly an afterthought, or just rendered necessary as a consequence of timber extraction.

Most national forest policy issuances, except in Indonesia, seldom mention NTFPs, or may only have definitions of it, sometimes even referring to them as minor produce still. National forest policy carries no specific agenda to promote the development, management, and sustainable utilization of NTFPS except perhaps to spell out rules on extraction, export, and the charging of fees thereof, and always along rules that more appropriately apply to timber. The absence of specific policies on NTFPs makes it difficult for the private sector to set out long-term plans for plantation and business enterprise development involving NTFPs. Indonesia, on the other hand, has recently completed a set of NTFP-specific policies designed to stimulate development and production of 30 priority NTFPs through the establishment of centers of excellence for the 30 NTFPs across the country. Table 4 lists 24 of such NTFPs and the proposed location of the centers tasked to initiate projects focusing on their respective niche NTFPs.

Despite the fact that Indonesia has embraced programs to aggressively develop its NTFPs, one policy it has recently implemented appears to be producing an opposite effect. The Trade Ministry Decree 35 issued in 2011 imposed a ban on raw and semi-processed rattan exports starting in January 2012. The intention was to revive the local rattan manufacturing industry and encourage the production and consumption of Indonesian home-produced rattan items. The restriction on exports initially resulted in stocks that could not be absorbed by the local industry, resulting in farmers cutting down on their production. This has reduced supply that caused the skyrocketing of rattan prices, setting off complaints not only from the rattan furniture manufacturers but also among those engaged in rattan furniture restoration business that needs good quality rattans with a wide range of sizes. The rattan heritage craft business practitioners are now petitioning government to allow the issuance of special license to established companies to avert further losses by these companies. There is also talk about establishing rattan buffer stock to accommodate farmers' stocks and ensure long-term supply of the material. On the other hand, a representative of the Indonesia Trade Ministry claimed that the ban on raw rattan exports had brought benefits to rattan industries as indicated by the increase in their rattan-based product exports from January-August 2012 compared to the same period in 2011 (http://www.antaranews.com/en/news/84455/indonesian-govt-claims-increase-in-rattan-exports). Clearly, the whole range of possible impacts of a policy should be anticipated in order to avoid complications that could arise notwithstanding the policy's good intentions.

Availability/Access to information

NTFPs play crucial roles in providing subsistence, medicine, house construction materials, personal accessories and furnishings for the home, and as basis for cash incomes and other livelihood opportunities for rural communities and increasingly, even among indigenous peoples. But NTFPs and the people who depend on them are located in remote areas away from the knowledge centers where the academe and research institutions that undertake studies designed to improve various facets of NTFP use such as on their propagation, management, harvesting, storage, processing and utilization are found. Useful data or information, or new technologies generated from NTFP researches hardly get through to farmer-gatherers, households, and rural-based entrepreneurs. It is also likely that local politicians and government field workers who make decisions pertinent to the access of NTFPs for use by indigenous peoples and rural residents do not get hold of the latest information on the NTFPs. The consequence of this lack of connection between technology developers and NTFP users can come in terms of pervasive use of inappropriate cultivation practices, destructive NTFP collection and harvesting methods, improper storage systems, and wasteful processing and utilization techniques.

On the other hand, because research centers are removed from the locations of communities that use NTFPs, research activities can be out of sync with what the community needs. Some NGOs in Myanmar lamented the apparent lack of usable technology from the research institute that they can introduce to communities as they go about their tasks to help develop NTFP-based enterprises for livelihood generation. NGOs have the impression that researchers do not go out often to find out for themselves what rural dwellers actually need.

In all likelihood, some indigenous practices that have been used for long are more appropriate than newly-developed technologies, only that they work under specific conditions. There should be a reason when traditional practices fail, and science must be able to help communities find out why. Researchers must therefore immerse themselves more in NTFP-using communities to be able to identify problems where science-directed investigation can provide the needed answers or solutions.

Table 4. NTFPs in Indonesia with proposed regional centers of development (Based on information provided by J. Tarigan, NTFP-EP Indonesia).

INDONESIA'S PRIORITY NTFPs

WATERSHED MANAGEMENT BODY	**NTFP PRIORITY**	**CENTER LOCATION/CLUSTER** **DISTRICT/PROVINCE**
I. BASED ON DECISION LETTER NO.SK.22/V BPS/2010		
Kahayan	Rotan/Rattan (*Calamus sp.*)	Katingan District, Central Kalimantan
Unda Anyar	Bambu/Bamboo (*Bambusa sp.*)	Bangli Distrcit, Bali
Citarum Ciliwung	Sutera/Silk (*Bombix sp.*)	Cianjur District, West Java
Baturusa Cerucuk	Gaharu/Eagle Wood (*Aquilaria sp.*)	Bangka Tengah District, Bangka Belitung
Dodokan Moyosari	Lebah Madu/Honey (*Apis sp.*)	Sumbawa Distrcit, Nusa Tenggara Barat
Serayu Opak Progo	Nyamplung (*Calophyllum inophyllum L.*)	Purworejo Distrcit, Central Java
II. BASED ON DECISION LETTER NO.SK.69/V-SET/2011		
Krueng Aceh	Kayu Manis/Cinnamon (*Cinnamomum burmannii*)	Aceh Tengah District, Aceh
Asahan Barumun	Kemenyan/Benzoin (*Styrax sp.*)	Tapanuli Utara District, North Sumatra
Brantas	Porang (*Amorphophallus vanabilis*)	Nganjuk District, East Java
Way Seputih Way Sekampung	Dammar Mata Kucing/Resin (*Shorea javanica*)	Lampung Barat Distrcit, Lampung
Benain Noelmina	Cendana (*Santalum album*)	Timor Tengah Selatan Distrcit, Nusa Tenggara Timur

Kapuas	Tengkawang (*Shorea sp.*)	Sanggau District, West Kalimantan
III. BASED ON DECISION LETTER NO. SK.65/V-BPS/2012		
Krueng Aceh	Jernang (*Daemonorops draco*)	Aceh Barat District, Aceh
Asahan Barumun	Kemiri/Hazelnut (*Aleurites moluccana*)	Samosir District, North Sumatra
Agam Kuantan	Pinus (*Pinus merkusii*)	Tanah Datar District, West Sumatra
Batanghari	Jelutung (*Dyera costulata*)	Tanjung Jabung Timur District, Jambi
Musi	Duku (*Lansium domesticum*)	Ogan Komering Ilir District, South Sumatra
Citarum Ciliwung	Melinjo/ (*Gnetum gnemon*)	Pandeglang District, Banten
Cimanuk Citanduy	Bambu/Bamboo (*Bambusa* sp.)	Tasilmalaya District, West Java
Pemali Jratun	Kapulaga/Cardamom (*Amomum cardamomum*)	Tegal District, Central Java
Brantas	Jahe/Ginger (*Zingiber officinale*)	Blitar District, East Java
Tondano	Aren/Sugar palm (*Arenga pinnata*)	Bolaang Mongondow District, North Sulawesi
Lariang Mamasa	Rotan/Rattan (*Calamus sp.*)	Mamuju District, West Sulawesi
Remu Resinki	Sagu/Sago (*Metroxylon sp.*)	Fakfak District, West Papua

Access to financing for the acquisition of new technologies/processing equipment

It is one thing to reach out to communities to introduce new technology, while procuring the resources to ensure its successful adoption is a different matter. To increase utilization of their research outputs, which is becoming more and more obligatory on the part of research institutes due to pressures from government or funding agencies, researchers are expected to reach out to the intended users of the technologies they have developed. Research and technology impact is generally measured in terms of how many have adopted the developed technology, and in the case of forestry research institutes, there is even greater pressure for researchers on NTFPs than on wood for the outputs to be shared and disseminated to potential users. As has been noted earlier, in most forestry research institutes across the ASEAN region, funding for NTFP research initiatives is small compared to wood and timber research, so there is even a larger need to maximize adoption of NTFP research results for greater impact in order to justify continued funding.

Although there is now greater expectation for researchers to undertake outreach activities, not many of them are equipped with skills to become effective change agents. Besides, the funding grants are limited to actual research conduct, and a very negligible sum, if at all, is available for research dissemination. Fortunately, in many of the ASEAN countries, there are NGOs that are better cut-out for this kind of work, who would only need to interface with researchers for a better grasp of the technology which they will eventually transmit down to the community. Offhand however, NGOs must also provide the resources that most communities expect to come along with the introduced technology. Generally, there is little problem for technologies with minimal inputs, for example, planting materials and handheld tools, but things get more difficult or complicated when the technology being promoted necessitates the acquisition of new equipment. There must be provisions for funding to acquire equipment, or the community must be willing to invest or procure loans to finance such acquisitions. It is essential that access to financing be made available and mechanisms should be put in place to enable communities to source funds for their enterprises.

Scaling up and transforming NTFPs to meet industry needs

Stiff competition and rapidly changing fashion trends put pressure on the cosmetic industry to always come up with new products that respond to fleeting consumer preferences. Ingredients from forest plants are incorporated to cosmetic products to impart specific properties, but amounts are small relative to the total components that make up the final product. Despite their low contribution to overall cosmetic product composition, NTFPs must have uniform and consistent chemical concentration in order for them to constantly provide the intended effect on the finished product. Justifiably, there is stringent quality control requirement for plant parts containing specific compounds that are of interest in cosmetic product manufacture. But once propagated outside of its natural environment, it is likely that chemical content will differ (in terms of structure and quantity) from plants grown in the wild. The chemical composition of plantation-grown plants is influenced by many factors such as soil, water and light which are difficult to control in the field. Besides, the capacity of forest plants to produce the desired natural products production may be altered once they are planted on a larger scale and become exposed to inputs such as fertilizer application and artificial watering. Only through sustained, continuous field trials and experiments will information be generated on how to best manipulate the plants' microenvironment to achieve consistency in the yield and quality of plant natural compounds that are of interest to industry.

Far more substantial costs are incurred in pursuing long-term studies designed to track plant responses to artificial production inputs, and unfortunately, funders of research such as the government are generally impatient providers of financial grants for research programs. This makes it imperative for the private sector to intervene, particularly in the provisioning of funds for contract research, regardless of how long the research activity will take, with the expectation that the research will produce an output that will positively redound to the industry in the future. Research centers to be established in Indonesia that focus on natural products and oil-bearing plants, can initiate research activities along this line. Mechanisms to accelerate partnerships with and between private enterprises must be in place, including the formulation of incentives to reward investments in natural plant products research.

Strategies and Mechanisms for NTFP Technology Development and Information Sharing

In line with the ASEAN member countries' commitment to promote the forestry sector as a model in forest management, conservation and sustainable development, the creation of an environment that enhances NTFP technology sharing across the region affords an opportunity for meaningful cooperation that will lead to the realization of such goal. Towards this end, strategies and mechanisms are herein proposed to lay the roadmap for encouraging exchange in information, the build-up of capacity and skills, and possibly trade in NTFPs within the region.

Albeit some small differences occur in the NTFP species that are present in the countries within the region, the ASEAN member countries do not differ much in terms of patterns and reasons for NTFP access, harvest, and use, as well as the levels of development and understanding of the importance of NTFPs to the national economies. In almost all countries, there is appreciation of the role of NTFPs in providing the raw materials that support cottage- or community-level enterprises in the rural areas, in the long tradition of dependence of indigenous peoples on NTFPs for subsistence and other basic needs, in the potential of NTFPs as a storehouse needed for medicine, cosmetics, and other industrial products, and the complementation between forest ecosystems and biodiversity resources that include all NTFPs. However, the forest-dependent IP groups, communities, and/or enterprises in the different ASEAN countries differ in the extent with which they realize benefits from NTFPs. For example, there are countries in the ASEAN that engage in the mere trading (sometimes illegal) of raw, unprocessed NTFPs across the borders with adjoining countries, resulting in meager cash incomes that barely trickle down to the gatherers of such products. At worse, in order to increase revenues, there is tendency to increase collection volumes that endanger the sustainability of some NTFPs. Some countries, on the other hand, are well-ahead in their value addition capacity for selected NTFPs but are faced with problems of supply to sustain production.

Creating a network of institutions in the different ASEAN countries, established on the basis of capacity that already exists in each country, will facilitate cooperation on NTFPs across the region. We list below the strengths in each of the ASEAN countries, around which “centers of excellence” can be founded with regional support and vision, for the purpose of extending to the other countries, lessons and experiences learned, as follows:

a) Laos – may house a center on forests for food security, including forest food processing and technologies, as well as on certification of NTFPs in view of its pioneering efforts on rattan certification;

b) Indonesia – may spearhead the creation of an ASEAN policy development center on NTFPs, having instituted country-wide regional centers of excellence, with each center being tasked to get business, community, government and non-government organizations (NGOs) to work together on priority programs and activities on a specific NTFP species to stimulate its development, including the conduct of research and development initiatives

c) Philippines – may tap the Cebu Furniture Industries Federation to become a regional center that will build capacity on sustainable designs and the use of alternative, eco-friendly materials

d) Cambodia – the partnership between CEDAC and NTFP-EP and the network of communities that supply them with marketable goods serves as an exemplary model for community-based enterprise development that can be replicated across ASEAN

e) Malaysia – has successful collaborative R&D efforts between government and industry and the country’s experience in undertaking collaboration of this nature can be harnessed to assist the other countries in developing their own capacity for government-private sector partnership in NTFP research and technology innovations

f) Myanmar – has a living collection of medicinal plants within the campus of the Forest Research Institute in Yezin, Nay Pyi Taw and such presence enabled the development of expertise in identification, propagation, and maintenance of these plants

Although Vietnam was not included in the countries visited, we have learned enough about its capacity for machine design and development (for example, its success in producing equipment for rattan and bamboo processing), which can be harnessed to help in the design and fabrication of machineries for the processing of different NTFPs in the region.

Regional coordination among the proposed country-based centers can be lodged in an ASEAN expert working group on NTFPs. Among its responsibilities are the conduct of, and support of ASEAN-wide NTFP value chain analyses and implementation of interventions to complement national activities, and to facilitate the process of responding to expressed NTFP capacity-building needs in a member country by mobilizing the center in the other countries where strength in the area of interest exists. They could also mainstream and put NTFPs on a higher profile in the preparation of the AEC blueprint and in the involvement of communities and their livelihoods in the global green economy. In addition, the expert working group can collaborate with the ASEAN Experts Group (AEG) on CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and the ASEAN Wildlife Enforcement Network (ASEAN-WEN) in combating illegal trade in NTFPs. As a guide towards accomplishing this task, the working group should come up with a regional list of commercially valuable NTFPs that contains information on their conservation status. Finally, it is worth mentioning that the ASEAN Socio-Cultural Community's (ASCC) blueprint for ensuring environmental sustainability embraces agreements to intensify regional cooperation in eradicating unsustainable practices including combating illegal logging and its associated trade. Extending the effort to include putting an end to illegal NTFP trade is a step towards a more holistic approach to achieving the goal of an environmentally sustainable ASEAN region.

Concluding Remarks

This scoping study was undertaken to document technologies on NTFPs in the ASEAN region that can be shared across countries and which can serve as basis for bilateral or multilateral collaboration in resource conservation and utilization, product improvement, and market development in the context of an integrated economic region. Six ASEAN countries namely Cambodia, Indonesia, Laos, Malaysia, Myanmar and the Philippines were visited for interviews with NTFP technology developers and users and when time and the private entrepreneur would permit, observations of operations in the plant or processing site. A questionnaire in the form of a matrix was also filled out by experts engaged in NTFP research and technology development from various research institutions and non-government organizations with track record in community empowerment through NTFP enterprise development.

The tropical rainforests in the six ASEAN countries, which serve as home to a diverse array of terrestrial plant resources, are in different states of development and/or exploitation. The diversity of forest plant species, hundreds of which are endemic in their own locale, is considered to be at great risk of being lost because of destructive logging and conversion of forest to other land uses. Many of these forest plants are utilized in ways that benefit indigenous peoples, upland dwellers, as well as provide sources of cash incomes or serve as bases for household, cottage or small-scale industries and are collectively referred to as non-timber forest products (NTFPs). While there are many common NTFPs that are in use in these countries, there are also differences arising from differences in species types and abundance, as well as in terms of relative importance for domestic consumption, local trade or international commerce. There are differences as well in the levels of production, harvesting and processing technologies in use for a number of NTFPs and in the nature of consumers and markets served by NTFP-based enterprises. Countries with high GDP have more developed processing technologies for NTFPs compared with countries whose GDP is low. Other factors that contribute to the level of technology in use include pervasive beliefs in traditional practices, local and national policies in place, competition between local and neighboring countries' demand for raw materials, and the countries' capacity to undertake NTFP research and development activities.

Technologies for bamboo, rattan, palms, wild food plants, honey, medicinal plants, natural plant dyes, and resins and exudates were documented. Malaysia and the Philippines have mature technologies for production of engineered-bamboo products, which convert hollow bamboo poles into all-bamboo products or deftly combined with wood to produce panels that can substitute for solid wood in furniture and construction use. The abundance of rattans in Indonesia partly explains the country's strength in commercial rattan furniture manufacture although a government policy banning raw rattan export in 2012 has negatively affected the supply for local rattan manufacturers and restorers of "antique" rattan furniture. Furniture manufacturers in Cebu City, Philippines have developed capacity for weathering scarcity in rattan raw material supply through novel furniture designs that incorporate other natural materials. Laos, with support from IUCN, pioneered rattan certification and a chain-of-custody process that engages community participation in sustainable rattan production and ensures that only sustainably-produced rattans are used in processing rattan products intended for export to the European market. Processing of rattan using cleaner production technologies have been introduced in Cambodia and one rattan furniture manufacturer had adopted technology and machineries developed in Vietnam to improve processing, as well as to reduce wastes and pollution from his factory. Another entrepreneur in Cambodia upgraded his operation by engaging in value-added activities through sun drying, mechanized bundling, and trading of dried *Corypha lecomtei* leaves to neighboring Vietnam.

Processed wild foods by the Ikalahan tribe in the Philippines have been successfully sold in supermarket chains all over the country. A group of Filipino entrepreneurs incorporated processed bamboo shoots into cakes, pastries and delicacies with a marketing strategy is focused on the products' health benefits. More than 700 forest food plants have been documented in Laos while an assessment study was recently completed in Cambodia covering the methods of collection and preparation as well as the impact of synthetic condiments on natural spices. In Indonesia, a rather sophisticated network of honey collectors was established that resulted in better organizational planning and business management, marketing, and better protection of forests. Clinical trials are also underway in Vietnam, Thailand and Malaysia on the various extracts and protein components in honey to validate the efficacy against a number of diseases such as diabetes, hypertension and cancer. The broader acceptance of honey in Indonesia can be traced to the popularity of Jamu in the country, which comprises of traditional healing practices that extensively employ native plants and other natural ingredients for the treatment of various human ailments.

The high value of *Aquilaria* wood has been the driver of technology development initiatives in Indonesia and Malaysia to increase the production of scented wood by inoculating standing trees with fungi that trigger the production of the desirable resin within trees in artificially-grown plantations. Naturally-growing stands have better quality scented woods, although these trees should be better left preserved and studied, for genetic conservation purposes and for better understanding of pest and disease resistance that can be applied in *Aquilaria* plantations. In the Philippines, a pilot plant was developed for refining Almaciga resin, and although the plant had been adopted by a private entrepreneur, it has never been in commercial operation due to inability to procure adequate resin supply. With assistance from the Forest Products Research and Development Institute (FPRDI) in the Philippines, the composition and other potential uses of oleoresin from *Dipterocarpus alatus* have been determined, broadening livelihood options for gatherers of the oleoresin in Cambodia.

Growing consumer preference for natural materials provided the impetus for the comeback of dyes from natural sources for imparting color to fabric, accessories and similar applications. There are now efforts in Indonesia to grow in plantations dye-producing plants such as Morinda and Jerenang to increase the supply of natural dyes. Various technologies in various stages of dye extraction and application have been developed by the Philippine Textile Research Institute (PTRI) in the Philippines, some of which have been adopted by small-scale handloom weaving industry in the country.

Despite a number of breakthroughs, research and technology development efforts on NTFPs in the ASEAN countries lag behind timber, accounting for only about 10% of funds allocated for research in institutions mandated to undertake forest R&D. There is a dearth of scientists undertaking NTFP research and technology work, although this is expected to change when the green economy becomes the more dominant market force, as the production and processing of NTFPs suit up better with green consumers.

To meet anticipated increased market demand for NTFPs, propagation and production of NTFP resources should be expanded, through inclusion in reforestation programs such as the National Greening Program in the Philippines and the One Billion Trees Program in Indonesia. National Policies should also be more aggressive in promoting NTFPs, and should be formulated in a manner that carefully considers all possible impacts to avoid being counterproductive in the end.

Within the ASEAN, there is a need to create an environment that enhances the sharing across boundaries, of technologies, expertise, and information on NTFPs. Establishing a network of institutions on the basis of strengths in each of the countries will provide the mechanism to facilitate technology and information exchanges between and among the different countries. This can come in the form of an ASEAN-expert working group on NTFPs tasked with the responsibilities of regional NTFP value chain analyses and in implementing interventions to upgrade the various NTFP value chains. Such group can collaborate with existing ASEAN task forces in pursuing efforts to intensify regional cooperation to promote sustainable forest management practices that will contribute towards equitable economic development and a more climate resilient ASEAN region.

References

Baird, I. 2009. Resin Tapping in Cambodia. Posted 27 August 2009 in Cambodia, Environment, Laos, Publications, Trans-Border Issues. Accessed February 5, 2013.

Cebu Furniture Industries Federation (CFIF). 2012. CFIF website. http://www.furniturecebu.com/

Chanchao, C. 2012. Bioactivities of Bee Products in Thailand. In 'Forest Honey, Health and Nutrition. A Symposium Publication. JMHI-NTFP-EP, Jakarta/Pontianak. pp. 13-16.

Chinh, P.H. & Trung, L. Q. 2012. Nutritional/Health Value of Bee Pollen and Best Ways to Handle and Preserve. In 'Forest Honey, Health and Nutrition. A Symposium Publication. JMHI-NTFP-EP, Jakarta/Pontianak. pp. 16-18.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2012.

Executive Order (EO) 879. Creating the Philippine Bamboo Industry Development Council (PBIDC) to promote the bamboo industry development. May, 2010.

Food and Agriculture Organization (FAO). 2002. Non-Wood Forest Products in 15 Countries in of Tropical Asia – An Overview. EC-FAO Partnership Programme (2000-2002).

Food and Agriculture Organization (FAO). 2010. Global Forest Resource Assessment.

Foppes, J. and Ketphanh, S. 2004. NTFP Use and Household Food Security in Laos. Paper presented at the NAFRI/FAO EM 1093 Symposium on "Biodiversity for Food Security", Vientiane, Laos, October 14, 2004.

Forest Management Bureau (FMB). (various years). Philippine Forestry Statistics. Department of Environment and Natural Resources, Visayas Ave., Quezon City, Philippines.

Hermanto. 2011. Forest Honey Network Ink. Improving the Welfare of the Local Community and Forest Conservation through Forest Honey Bee. Paper presented during the Mountain Conference held in Kathmandu, Nepal. International Centre for Mountain Development (ICIMOD)., August, 2011.

Hyman, E.L. 2003. Technology and the Organization of Production, Processing and Marketing of Non-Timber Forest Products. Chapter 11 in "Current Issues in Non-Timber Forest Products Research" (M. Ruiz Perez and J.E.M. Arnold, eds.) pp. 197-218.

India Ministry of Agriculture

Neubauer, I.L. 2012. Jamu: Why Isn't Indonesia's Ancient System of Herbal Healing Better Known? (Posted February 29, 2012). http://cempaka_health.blogspot.com/2012/03/_ - accessed February 2, 2013

Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD). 1991. Philippines Recommends for Bamboo. Los Baños, Laguna 4031 Philippines.

Statistical Yearbook for Asia and the Pacific. 2011.

Siebert, S.F. 2001. Harvesting wild rattan: opportunities, constraints and monitoring methods. http://www.fao.org/docrep/003/Y2783E/y2783e18.htm - retrieved April 8, 2013

Sulaiman,S.A. 2012. The Potential Health Benefits of Tualang Honey Based on Recent Research Findings. In 'Forest Honey, Health and Nutrition. A Symposium Publication. JMHI-NTFP-EP, Jakarta/Pontianak. Pp. 9-12.

Widiawati, D. 2009. The Revival of the Usage of Natural Fibers and Natural Dyes in Indonesian Textile. ITB J. Vis. Art & Des. Vol. 3, No. 2. 115-128.

Zvelebil, M. & Pluciennik, M. 2002. Historical Origin of Agriculture. The Role of Food, Agriculture, Forestry and Fisheries in Human Nutrition. Vol. I

http://www.antaranews.com/en/news/84455/indonesian-govt-claims-increase-in-rattan-exports

http://bioval.jrc.ec.europa.eu/products/ veget_map_insulare-sea/images/sea_ins_fomap1.gif&imgrefurl

http://davesgarden.com/guides/terms/go/2296/#b - April 9, 2013

http://knoema.com/atlas/ranks/GDP?gclid=CJjO8YKjiLUCFYp_6wodS0YAmg#

http://www.prb.org/pdf12/2012-population-data-sheet_eng.pdf

Appendix A. Documents/Reading materials received during the visits:

CAMBODIA

Cambodia Cleaner Production Programme. 2006. Mini-guide to Cleaner Production. Ministry of Industry, Mines and Energy. Phnom Penh, Cambodia.

Cambodia Cleaner Production Programme. 2011. Annual Report. Ministry of Industry, Mines and Energy. Phnom Penh, Cambodia.

Monin, V. 2012. Summary of Forestry Curriculum Credit System. Royal University of Agriculture Faculty of Forestry Science.

Non-Timber Forest Products Exchange Programme. 011. Guide to the Sustainable Collection and Management of Dipterocarp oleoresin or balsams. Published with funding by WWF, People and Knowledge of Highlanders, and My Village.

Savajol, N., Vanny, T., Joh, S., Bunthy, C., Chang, O., Nikles, B. and Khou, E. 2012. Aspects of Knowledge of Forests of the Bunong People of Dak Dam Commune. Food, Medicine and Other Uses Made from the Forest. Nomad RSI Cambodia Edition.

Tola, P. 2009. Beyond subsistence – Trade chain analysis of resin products in Cambodia. Published by Oxfam, Cambodia NTFP Working Group and the NTFP Exchange Programme.

Tola, P., Kimsay, S., Prum, S., Vanny, R., Touch, V. and Aquino, A. 2010. Economic Importance of Non-Timber Forest Products – Case studies on resin and rattan in Kampong Thom Province, Cambodia. Non-Timber Forest Products Exchange Programme with funding from Oxfam and support from the Forestry Administration Cambodia.

Visalsok, T. and De Korte, E. 2011. Pesticidal Plants in Cambodia.

Brochures

Cambodia Cleaner Production Office – Why is Cleaner Production Important?

SPIN – Sustainable Product Innovation – Vietnam Cleaner Production Office

INDONESIA

H. Jatnika Nanggamiharja. 2010. Rumah Bambu – Arsitektur Khas Jawa Barat. Pustaka RumahKebun.

Zuhud, E.A.M. 2011. Penembangan Desa Konservasi Hutan Keanekaragaman Hayati untuk Mendukung Kedaulatan Pangan dan Obat Keluarga (POA) Indonesia dalam Menghadapi Ancaman Krisis Baru Ekonomi Dunia di Era Globalisasi. Institut Pertanian Bogor, 19 November 2011.

Brochures

Centre for Forest Productivity Improvement Research and Development. 2011. Pusprohut – Pusat Litbang, Peningkatan Produktivitas Hutan.

Factory Visit 2012 Martha Tilaar Group. The Power of Beauty

Forest and Nature Conservation Research and Development Centre. (undated). Innovation of Gaharu technology by FORDA for Sustainable production, conservation and improvement of community livelihood.

Forest and Nature Conservation Research and Development Centre. (undated). Pest attack ***Heortia vitessoides*** in Gaharu Producing Tree Species.

Forest and Nature Conservation Research and Development Centre. (undated). Production & Utilization Technology for Sustainable Development of Eaglewood (Gaharu) in Indonesia.

JMHI Jaringan Madu Hutan Indonesia. Madu hutan, Sumber Keuntungan dari Hutan.

Kampoeng Djamoe Organik Martha Tilaar – Explore the Wonder of Indonesian Traditional and Natural Heritage (undated)

Koperasi Jasa Menenun Mandiri (JMM). (undated). Budidaya Tanaman Mengkudu (*Morinda sp*.) Non-Timber Forest Products – Exchange Programme (NTFP-EP)

Koperasi Jasa Menenun Mandiri (JMM). (undated). Budidaya Tarum Nila/ Indigo (*Indogofera*) & Rambutan Pasta.

Koperasi Jasa Menenun Mandiri (JMM). (undated). Emarek/Marek/Marik (Symplocos)/ Sebagai Campuran Bahan Pewarna Alam. Non-Timber Forest Products – Exchange Programme (NTFP-EP)

Our Heritage, Your Lifestyle. www.borneochic. com (undated)

Roshetko, J.M., Tolentino, E.L.T. Jr., Carandang, W.M., Bertomeu, M., Tabbada, A., Manurung, G.E.S. and Yao, C.E. 2010. Tree Nursery Sourcebook – Options in Support of Sustainable Development. Published by World Agroforestry Centre, Winrock International and the University of the Philippines Los Baños.

Rumah Bambu – Hap Cipta Rumah Bambu. (undated). Yayasan Indonesia

LAOS

Greijmans, M., Kethphanh, S., Lamxay, V. and Sengdala, K. Non-Timber Forest Products in the Lao PDR. 2007. Published by The National University of Lao PDR, The National Agriculture and Forestry Research Institute, and SNV Netherlands Development Organization.

Greijmans, M. and Hitzges, C. 2012. SNV Bamboo Programme. Approaches, Lessons and Innovations in Lao DR. Published by SNV,

Macqueen, D. (ed.), Baral, S., Chakrabarti, L., Dangal, S., du Plessis, P., Griffith, A., Grouwels, S., Gyawali, S., Heney, J., Hewitt, D., Kamara, Y., Katwal, P., Magotra, R., Pandey, S.S., Panta, N., Subdi, B., and Vermeulen, S. 2012. Supporting small forest enterprises – A facilitator's toolkit. Pocket guidance not rocket science! IIED Small and Medium Forest Enterprise Series No. 29. IIED, Edinburgh, UK.

Roscher, B., Lindsten, C., Brolund, P., Broberg, T. and Ledecq, T. 2011. Sustainable Rattan Design – the Mekong Region. Funded by the European Union through the WWF.

TABI Update. Issue No. 1, April 2011.

TABI Update. Issue No. 2, November 2011.

WWF Greater Mekong – Laos Country Programme. (undated). A Switch to Sustainable Rattan Product and Supply. Brochure.

Xayaphet, V. 2011. Sustainable Rattan Production – Manual for Small and Medium Enterprises in Lao PDR. WWF/LNCCI. Funded by the European Union through WWF's rattan project.

MALAYSIA

FRIM. 2011. Forest Product Services and Research at FRIM. FRIM in Focus.

FRIM. 2012. Forest Products Innovation. FRIM in Focus.

FRIM. 2012. Forest Products Division – Technical Services and Research and Development.

Fui, L.H. 2012. Eating for Good Health (4th Ed.). Samarata Publication.

Brochures

Anti-oxidant bougainvillea fest: Natural anti-oxidant standardized extract of *Bougainvillea glabra* petals (ekstrak bunga kertas) by Vimala, S., Shalini, M., Juliza, M., Abdull Rashih A., Rohana, S. and Norulaiman, Y.

Ciera. Eco-friendly multi-purpose disinfectant. With Plant based active ingredients

FRIM. Herbal Technology Centre

Ocimum sanctum 'Selashih Hitam.' (undated). Biopotential & bioefficacy evaluation of *Ocimum sanctum* Linn. towards neutraceutical product development by Vimala, S. *et al*., Natural Products Div., FRIM.

Ocimum basilicum 'Selashih Putih.' (undated). Biopotential & bioefficacy evaluation of *Ocimum basilicum* towards neutraceutical product development by Vimala, S. *et al*., Natural Products Div., FRIM.

MYANMAR

Forest Research Institute Myanmar. (undated). Non-wood Forest Products Research Activities in FRI, Myanmar.

Forest Research Institute Myanmar. 2007. Handbook on Bamboo Properties in Myanmar. FRI, Forest Department, Ministry of Forestry, Gov't of the Union of Myanmar.

Forest Research Institute Myanmar. 2010. Bamboo and Rattan Products of Myanmar. FRI, Forest Department, Ministry of Forestry, Gov't of the Union of Myanmar. With funding from Common Fund for Commodities (CFC) and INBAR.

Myint, D.K. 2002. A Pharmacognostic study on Ta-bin-shwe-hti (*Nervilia aragoana* Gaud.) and its commercial value. FRI, Forest Department, Ministry of Forestry, Gov't of the Union of Myanmar.

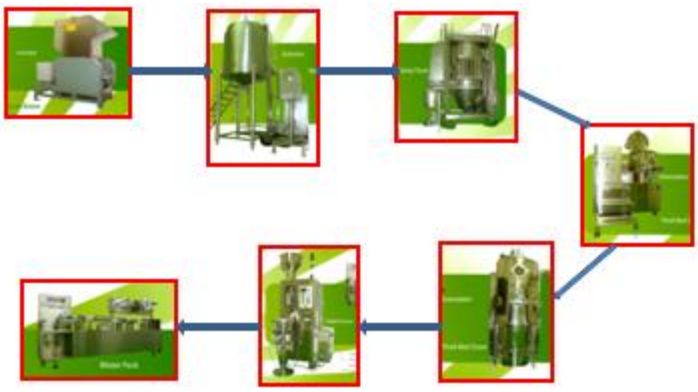
Myint, K.W. 2003. Preliminary studies on the establishment of S-mi-tauk (*Gloriosa superb* Linn.) Plantation and its socio-economic potential. FRI, Forest Department, Ministry of Forestry, Gov't of the Union of Myanmar.

San, M.M., and Myint, K.W. 2009. Preliminary survey on medicinal values of some *Dendrobium* species occurring in Kutkai Township, Northern Shan State. FRI, Forest Department, Ministry of Forestry, Gov't of the Union of Myanmar.

Brochures

Networking capacity building and information and knowledge sharing. Food Security Working Group

Appendix B.



Appendix Figure A. Process flow and equipment at the Herbal Technology Centre, Forest Research Institute, Malaysia.

Appendix Table C. Important NWFPs in six ASEAN countries (Source: FAO 2002).

Category of NTFPs	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines
Most important	• Resin • Rattan • Bamboo	• Rattan • Bamboo • Resins[a] •Tengkawang seed •Sandalwood oil •Cayeput oil •Honey • Shellac	• Medicinal plants (e.g., cardamom) • Food (nuts, fern roots, fruits) • Fibres (e.g., paper mulberry) • Exudates (damar resin, oleoresin, benzoin)	• Rattan • Bamboo • Medicinal plants • Wild fruits	• Bamboo • Rattan • Edible bird's nests • Natural rubber	•Rattan • Bamboo • Fibres •Vines • Palms • Exudates
Other NTFPs	• Mushroom • Medicinal Plants • Incense	• Fruits • Medicinal plants	• Spices • Stems (bamboo, rattan) • Perfumes • Cosmetics (incense) • Orchids	• Palm • Resin • Tannin • Ferns • Barks • Vegetables • Wood-oil	• Spices • Medicinal plants • Straws • Tanning barks • Perfumes • Exudates • Honey and beeswax • Bushmeat •Lac • Bat guano	• Essential oils • Dyes • Wild food plants •Medicinal plants •Honey • Butterflies

[a]gondorukem and turpentine, jelutung gum, damar, kemenyan, gaharu and kopal

Appendix Table D. Selected important bamboo species in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
Russey prey (*Dendrocalamus giganteus*)	Bambu duri, pring gesing (*Bambusa blumeana*)	Mai bong (*Bambusa tulda*)	Buluh betong (*Dendrocalamus asper*)	Kayin-wa (*Melocanna bambusoides*)	kawayan tinik (*Bambusa blumeana*)
Rüssèi khléi (*Bambusa vulgaris*)	Bambu ampel (*B. vulgaris*)	Mai sanot (*Gigantochloa apus*)	Buluh duri (*Bambusa blumeana*)	Kyathaung (*Bambusa polymorpha*)	kawayan kiling (*B. vulgaris*)
Raisai (*B. arundinacea*)	Pring betung (*Dendrocalamus asper*)	Mai lai (*G. albociliata*)	Buluh galah/ tilan/pering/ pengat (*B. hesterotachya*)	Tin-wa (*Cephalostachyum pergracile*)	bayog (*Dendrocalamus merrilianus*)
Rusey Khley (*B. bambos*)	Pring tali (*Gigantochloa apus*)	Mai hok (*Dendrocalamus hamiltonii*)	Buluh minyak (*B. vulgaris*)	Hmyin (*Dendrocalamus strictus*)	giant bamboo (*D. asper*)
Rusey Srok Chin (*B. burmanica*)	Wulung (*G. atroviolacea*)	Mai phang (*D. lonoifimbriatus*)	Buluh gading (*Bambusa vulgaris var. striata*)	Wapyu (*D. membranaceus*)	bolo (*Gigantochloa levis*)
Rusey Srok (*B. flexuosa*)	Bambu ater (*G. atter*)	Mai khom (*Indosasa sinica*)	Buluh beting (*Gigantochloa levis*)	Thaik (*Bambusa tulda*)	kayali (*G. atter*)
Rusey Ping Pong (*Oxytenanthera densa*)	Buloh busi (*G. hasskarliana*)	Mai hia (*Schizostachyum blumei*)	Buluh tumpat (G. ligulata)	Wabo-myet-san-gye (*D. hamiltonii*)	buho (*Schizostachyum lumampao*)
Rusey Prech *(Arundinaria ciliata, A. A pusilla*)	Buluh betung (*G. levis*)	Mai sot (*Oxytenanthera parviflora*)	Buluh semantan (*G. scortechinii*)	Waya (*Oxythenanthera nigrociliata*)	anos (*S. Lima*)
Rusey Rlek (*B. blumeana*)	Tiying tabah (*G. nigrociliata*)		Buluh beti (*G. wrayi*)	Wabo (*D. brandisii*)	laak (*Sphaerobambos philippinensis*)
	Bambu gombong (*G. pseudoarundinacea*)		Buluh nipis (*Schizostachyum brachycladum)*	Kayin (*Melocanna bambusoides*)	
	Fishpole bamboo (*Phyllostachys aurea*)		Buluh semeliang (*S. grande*)	Thana (*Thyrsostachys oliveri*)	
	Buluh tamiang (*Schizostachyum blumei*)		Buluh dinding (*S. zollingeri*)	Wagok (*Oxytenanthera albociliata*)	

Appendix Table E. Selected important rattan species in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
rum peak (*Calamus dioicus*)	Manau (*Calamus manan*)	Wai thoun (*Calamus poilanei*)	Rotan manau (*C. manan*)	Kyet-u-kyein (*Calamus platyspathus*)	palasan (*Calamus merrillii*)
Lpeak (*Calamus salicifolius*)	Sega (*C. caesius*)	Wai hom (*C. gracilis*)	Sega, leutik (*C. caesius*)	Yamata kyein (*C. latifolius*)	limuran (*C. ornatus* var. *philippinensis*)
Phdao dambang (*Calamus rudentum*)	Irit (*C. trachycoleus*)	Wai khom (*C. viminalis*)	Paikat irit (*C. trachycoleus*)	Kabaung-kyein (*C. longisetus*)	tagiktik (*C. filispadix*)
Phdao krek (*Calamus viminalis*)	Leulues (*C. asperrimus*)	Wai nyeh (*C. tenuis*)	Rotan manau tikus (*C. tumidus*)	Ye-kyein (*C. floribundus*)	sika (*C. caesius*)
Phdao chhveang (*Calamus palustris*)	Hoe cacing (*C. ciliaris*)	Wai thok (*C. solitarius*)	Rotan semambu (*C. scipionum*)	Kyein-bok (*C. myrianthus*)	sika-sika (*C. microsphaerion*)
Phdao soam (*Daemonorops jenkinsiana*)	Rotan tohiti (*C. inops*)	Wai nam hang (*C. palustris*)	Wi tulang (*Calamus bacularis*)	Thaing-kyein (*C. erectus*)	Tumalim (*C. mindorensis*)
Preah Phdao (*Korthalsia laciniosa*)	Rotan penjalin rawa (*C. karuensis*)	Wai thabong (*C. rudentum*)	Wi janggut (*C. conjugatus*)	*Korthalsia laciniosa*	Malacca cane (*C. scipionum*)
Phdao Reussey (*Myrialepis paradoxa*)	Rotan boga (*C. koordersianus*)	Wai hangnou (*C. tetradactylus*)	Rotan perut ayam (*C. corneri*)	*Myrialepis paradoxa*	tandulang gubat (*C. dimorphacanthus*)
Phdao Reussey Yeak (*Plectocomia elongata*)	Rotan gelengdage (*C. melanoloma*)	Wai nam lueang (*C. platyacanthus*)	Wi takong (*C. crassifolius*)	*Plectocomiopsis geminiflora*	biri (*C. siphonophatus*)
Teang oa (*Plectocomiopsis gemiflora*)	Datu (*C. minahassae*)	Wai niew (*C. nambariensis*)			arurog (*C. javensis*)
Phdao tuk (*Calamus godefroyi*)	Ombol (*C. spectabilis*)	*C. guruba*			ditaan (*Daemonorops mollis*)
C. guruba	Rotan umbol (*C. symphysipus*)	*C. siamensis*			rogman (*D. oligolepis*)
	Rotan beula (*Ceratolobus glaucescens*)	*Daemonorops jenkinsiana*			sumulid (*D. ochrolepis*)
	Rotan bulu (*Korthalsia junghuhnii*)	*Myrialepis paradoxa*			
		Korthalsia laciniosa			

Appendix Table F. Selected important medicinal plant species in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
Kratumthet (*Leucaena leucocephala*)	patchouly oil (*Pogostomon cabin*)	Fek hom (*Vetiveria zizanioides*)	Hempedu bumi (*Andrographis paniculata*)	Bomayaza (*Rauwolfia serpentina*)	akapulko (*Cassia alata*)
Do khouch (*Dioscorea hispida)*	gelam or kayu putih tree (*Melaleuca leucadendron* and *M. minor*).	Kheua haem (*Coscinium fenestratum*)	Kacip Fatimah (*Labisia pumila*)	Subyu (*Acacia arabica*)	lagundi (*Vitex negundo*)
Chres (*Albizzia lebbeck*)	vetiver oil (*Andropogon maricatus*)	Kheua khao ho (*Tinospora crispa*)	Misai kucing (*Orthosiphon stamineus* syn. *speciosa*)	Hnaw (*Adina cordifolia*)	niog-niogan (*Quisqualis indica*)
Nhoër préi (*Morinda tomentosa)*	wintergreen (*Gaulsheria fragantissima*)	Chandai (*Dracaena loureiri*)	Mengkudo (*Morinda citrifolia*)	Banbwe (*Careya arborea*)	pansit-pansitan or ulasimang bato (*Peperomia pellucida*)
Sdao *(Azadirachta indica)*	cinnamon oil (*Cinnamomum culilawan*)	Houa sam phan hou (*Hydnophytum formicarum*)	Tongkat ali (*Eurycoma longifolia*)	Zibyu (*Emblica officinalis*)	sambong (*Blumea balsamifera*)
Dangheth (*Cassia alata*)	citronella oil (*Andropogon nardus*)	Khok ien don (*Eurycoma harmandiana*)	*Uncaria calophylla, U. gambir*	Nalingyaw (*Litsea lancifolia*)	tsaang gubat (*Carmona retusa*)
Khmear (*Amomum galangal*)	castor oil (*Ricinus communis*)	Mak chong (*Scaphium macropodum*)	Ketum (*Mitragyna speciosa*)	Ondon (*L. glutinosa*)	
tromoung sek (*Gelonium multiflorum*)	cinchona bark (*Cinchona officinalis*)	Mak kabao (*Hydnocarpus kurzii*)	Selada; Selayar hitam gajah beranak (*Goniothalamus macrophyllus*)	Taw-shauk (*Citrus medica*)	
dong koa (*Diospyros* spp.).		Mak seng beua (*Strychnos nux-vomica*)		Pwegaing (*Cassia angustifolia*)	

Appendix Table G. Selected important palm plant species in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
Sla condor (*Pinanga duperreana*)	Sago (*Metroxylon sagu*)	San (*Rhapis laoensis*)	Nipa (*Nypa fruticans*)	*Areca triandra*	buri (*Corypha elata*)
Sa La (*Areca macrocalyx*)	Salac (*Salacca zalacca*)	Mak tao (*Arenga westerhoutii*)	Tahan bertam (*Eugeissona brachystachys*)	*Caryota mitis*	nipa (*Nypa fruticans*)
Oncosperma tigillarium	Sal (*Johannesteijsmannia altifrons*)		Bertam (*E. tristis*)	*Licuala peltata*	anahaw (*Livistona rotundifolia*)
Salacca wallichiana	Aren (*Arenga obtusifolia* syn. *pinnata*)		Serdang (*Pholidocarpus macrocarpus*)	*Phoenix acaulis*	ambolong (*Metroxylon sagu*)
dramn, satnlan, khjêh (*Corypha lecomtei*)	Sagu moro (*Caryota rumphiana*)		Langkap (*Arenga microcarpa*)	*P. sylvestris*	
	Gebang (*Corypha utan*)		Nibong (*Oncosperma tigillarium*)	*Salacca wallichiana*	
	Limbun (*Hydriastele costata*)		*Metroxylon sagu*		
	Palas (*Licuala peltata*)		Mudor (*Arenga hastata*)		
	Serdang (*Livistona rotundifolia*)				
	Bayeh (*Oncosperma horidum*)				
	Wanga (*Pigafetta filaris*)				
	Pinarig (*Pinanga caesia*)				
	Salak (*Salacca affinis*)				

Appendix Table H. Selected important species that produce resins, exudates and scented woods and barks in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
chheu teil (*Dipterocarpus alatus*)	Godorukem (*Pinus merkusii*)	Khedsana (*Aquilaria crassna*)	*Cinnamomum mollissimum*	Thitsi (*Melanorrhoea usitata*)	pili (*Canarium ovatum*)
cheur chong (*Shorea vulgaris*)	Jelutong (*Dyera costulata*)	Fek hom (*Vetiveria zizanioides*)	Kesom oil (*Polygonum minus*)	*Pinus kesiya*	piling liitan (*C. luzonicum*)
phchök (*Shorea obtusa*)	Pontianak (*D. lowii*)	Khe hom (*Cinnamomum cassia*)	Gum Arabic (*Acacia senegal*)	Kanyin (*Dipterocarpus alatus* and *D. tubinatus*)	pagsahingin (*C. asperum*)
Kanndol (*Careya arborea*)	Jelutung gum (*D. latifolia*)	Khi si (*Shorea obtusa, Vatica harmandiana, Anisoptera costata*)	Gum ghatti (*Anogeissus latifolia*)	In (*D. tuberculatus*)	Benguet pine (*Pinus kesiya*)
Chorchong (*Shorea guiso*)	Damar (*Shorea javanica*)	Mak keua (*Diospyros mollis*)	Neem (*Azadirachta indica*)	Subyu (*Acacia arabica*)	Mindoro pine (*P. merkusii*)
	Gum dammar (*Hopea sp.*)	Nam man nyang (*Dipterocarpus alatus*)	Guggal (*Commiphora weightii*)	Karamet (*Mansonia gagei*)	Almaciga (*Agathis philippinensis*)
	Resin dammar (*Vatica sp., Dryobalanops sp.*)	Nyan (*Styrax tonkinensis, S. benzoides*)	Gum karaya (*Sterculia urens*)	Santagu (*Santalum album*)	apitong (*Dipterocarpus grandiflorus*)
	Benzoin kemeyan (*Styrax benzoin, S. sumatrana*)	Nyang bong (*Persea kurzii*)		Taungtan-gyi (*Premna integrifolia*)	panau (*D. gracilis*)
	Gaharu (*Aquilaria malaccensis*)	Peuak meuak (*Boehmeria malabarica*)		Thit-hmwe (*Aquilaria agallocha*)	palosapis (*Anisoptera thurifera*)
	Resin kopal (*Agathis alba*)	Sisiet (*Pentace burmanica*)		Thanatkha (*Hesperethusa caenulata*)	dalingdingan (*Hopea malibato)*
	Sandalwood (*Santalum album*)	Som poi (*Acacia concinna*)			almon (*S. almon)*
	Nyampong (*Calophyllum inophylum*)				
	Tenglawang (*Shorea sp.*)				
	Jernang (*Daemonorops draco*)				

Appendix Table I. Selected important species that are tapped as wild plant food sources in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
Kuy (*Baccaaurea matleyana*)	tengkawang tungkul (*Shorea stenoptre*)	Houa koi (*Dioscorea hispida*)	Illipe nut (*Shorea sp*.)	Hpala (*Elettaria cardamomum*)	Several species of bamboo used for shoots
Pika (*Oroxylum indicum*)	tengkawang majau (*S. lepidota*)	Khe hom (*Cinnamomum cassia*)	Petai (*Parkia speciosa*)	Ngayok-kaung (*Piper nigrum*)	Rattan shoots
Maka prey (*Spondias malayana*)	tengkawang layar (*S. gysbertsiana*)	Dok khae (*Markhamia stipulata*)	Kepayang (*Pangium edule*)	Peikchin (*P. longum*)	antipolo or gumihan (*Artocarpus blancoi)*
Kooy (*Willughbeia eludes*)	tengkawang terendak (*S. seminis*)	Het bot (*Lentinus polychrous, L. squarrosulus*)	Paku iban (*Diplazium esculentum*)	Karawe (*Cinnamomum sp*.)	Kamansi (*A. altilis*)
Samrong (*Scaphium macropodum*)	Kemiri (*Aleurites moluccana*)	Het hou nou (*Auricularia polytricha*)	Kemiding pao (*Stenochlaena palustris*)		Bignay (*Antidesma bunius*)
Topeang (Bamboo shoots, various species)	Duku (*Lansium domesticum*)	Hom nam (*Amaranthus spinosus*)	Tebus, tubuh tana (*Etlingera elatior*)		Datiles (*Muntingia calabura*)
	Melinjo (*Gnetum gnemon*)	Phak khan chong (*Limnocharis flava*)	Lanau (*Commelina paludosa*)		sugar palm (*Arenga pinnata*)
	Kayu manis (*Cinnamomum burmannii*)	Kheua sa khan (*Piper ribesiodes*)	Gelabak (*Pseuderanthemum borneense*)		Pako (*Athyrium esculentum*)
	Porang (*Amorphopalus variabilis*)	Ko deuay (*Castanopsis indica*)			
		Mak bok (*Irvingia malayana*)			
		Mak fai (*Baccaurea sapida*)			
		Mak kok (*Spondias pinnata*)			
		Mak pheuang pa (*Averrhoa carambola*)			
		Phak kha nhaeng			

		(*Limnophila geoffrayi*)			

Appendix Table J. Selected important species of natural plant dyes in the six ASEAN countries.

Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines
Sangke (*Combretum quadrangulare*)	Tarum or tom plant (*Indigofera tinctoria*)	Mak lin mai (*Oroxylum indicum*)	Tarom (*Baphicacanthus cusia* syn. *Strobilanthes cusia*)	Meyaing (*Indigofera sp.*)	Bangkoro (*Morinda citrifolia*)
Ko koh (*Sindora cochinchinensis*)	*I. suffruticosa*	Mai sak (*Tectona grandis*)	Tarum, tarum hutan (*Marsdenia tinctoria*)	Pauk (*Butea monosperma*)	Bayok (*Pterospermum diversifolium*)
	Mengkudo / Noni (*Morinda citrifolia*)	Chandai (*Dracaena cochinchinensis*)	Daun susu babi (*Adenostemma lavenia*)	Megyi (*Strobilanthes flaccidifolius*)	Bignay (*Antidesma bunius*)
	Soga (*Peltophorum ferrugineium*)	Kheua haem (*Coscinium fenestratum*)		Pein-ne (*Artocarpus heterophyllus*)	Katmon (*Dillenia philippinensis*)
	Sepang (*Caesalpinia sappan*)			Nibase (*Morinda sp.*)	Langka (*Artocarpus heterophyllus*)
	Tinggik (*Cereop candolleana*)			Tein-nyet (*Caesalpinia sappan*)	Malungai (*Moringa oleifera*)
	Jati (*Tectona grandis*)			Te (*Diospyrus burmanica*)	Narra (*Pterocarpus indicus*)
	Pinang (*Areca catechu*)			Sha (*Acacia catechu*)	Sibukau (*Caesalpinia sappan*)
	Kunyit (*Curcuma domestica*)				

Appendix Table K. Available NTFP Technologies in ASEAN countries (by type of NTFP, country, and nature of technology). (Sources of information: Filled out matrices submitted by various partner R&D institutions).

Bamboo

Country	Name of technology	Brief description	Year of development	Adopters/Users of technology
Propagation and management				
Philippines	Bamboo nursery and plantation development for Kawayan tinik, Kawayan kiling, Giant bamboo and Bolo	Use of one-node cutting raised in the nursery for 6-8 months, with use of potting media consisting of rice hull, chicken dung, compost and garden soil at 1:2 ration	1987-1995	Researchers, farmers, LGUs, academe
Processing Technologies/Product Development				
Malaysia	Plybamboo	Bamboo strips were used to produce bamboo panel	2004	Recommended for House, decking but no commercial takers
	C-Bam	Chopped strand bamboo composed into panel	2005	Recommended for Construction formwork, decking etc. but no commercial takers
	`Wood-V-Bam'	Consists of bamboo skewer orientated parallel and glued together by a process into various components	2006	Recommended for furniture, construction but no commercial takers
	Charcoal/activated carbon from bamboo	Converts bamboo into charcoal for use as activated carbon	2002, 2006	Recommended as feedstock for activated carbon industry; for use in supercapacitors
	MyScrim Bamboo	High-strand bamboo strips/splits compressed.	2005	Recommended for

				Construction, furniture
Philippines	Bamboo Veneer lathe	Can produce bamboo veneers of varying thicknesses (0.5, 0.75, 1.0, 1.25, 1.5, 1.75 and 2.0 mm) at 45 and 82 cm width.	2010	CFIP (Chamber of Furniture Industries of the Philippines) Manila Chapter
	Bamboo Flattening Machine	Can flatten bamboo culms into planks to create engineered bamboo products	2011	CFIP (Chamber of Furniture Industries of the Philippines) Manila Chapter
	Bamboo Charcoaling kiln	Converts bamboo into high quality charcoal & pyroligneous liquor (PL) or industrial vinegar	2009	In-hand Abra company
	Bamboo Pulp and Papermaking	Bleached sulfate and sulfite bamboo pulps were produced. Alternate material to abaca	1980s	None yet
	Bamboo preservation	Non-chemical and chemical treatment methods were developed. High pressure sap displacement (HPSD) equipment is also available at FPRDI	Early 2010	Bamboo producers, traders and manufacturers
	Heat treatment	Safer than methyl bromide (MB) fumigation; MB 60 times more damaging to the ozone layer than chlorine & is blamed for 5-10% of worldwide ozone depletion	Mid-2010	Bamboo producers, traders and manufacturers
	Bamboo Dryer	Dries bamboo at desired moisture content. It has flue-pine as heat exchanger and motor fans, vents.	Mid 2010	Bamboo producers, traders and manufacturers
	Miscellaneous technologies	Processing technologies like turning/machining, bending, removal of cutin, special finishing effects, bamboo panels (bamboo-mats, corrugated sheet, cement boards, etc)		
Sustainable management				
Laos	Sustainable	Sustainable forest management technology to protect	1996-now	Villagers, Communities,

	management for Bitter Bamboo Shoots (*Indosasa sinica*) production	and manage bitter bamboo forest, to promote villagers' livelihood through harvesting and sale (export of raw bamboo shoot to China). A village sustainable bamboo shoot management administration called Village Bitter Bamboo Shoot Forest Management Committee had been established and has operated since 2000.		Social Organizations and projects in govern-ment sector, NGOs, visitors in Nampheng Village in Oudomxay Province (North of Laos)
	Sustainable forest management for Bamboo	Sustainable Bamboo Forest Management plans are carried out to manage the bamboo forest with sustainable use, promote and enhance the livelihood of rural people, trade handicraft and furniture bamboo products	2006-now	Villages in Sangthong Districts, Vientiane Capital, Vientiane, Houaphanh, Xiengkhouang and Luangprabang Provinces.

Rattan

Country	Name of technology	Brief description	Year of development	Adopters/Users of technology
Propagation and management				
Philippines	Rattan seedling production and plantation establishment	Propagation through seeds, wildlings, and suckers (side shoots or aerial suckers); developed procedure for raising rattan on a plantation scale for reforestation areas or second-growth forests	1995-1998	Researchers, farmers, LGUs, academe
Sustainable management				
Laos	Sustainable management of Rattan (small and big canes)	Sustainable Rattan Management plans are carried out in 7 villages; harvesting of rattan in certified areas; rattan splitting and handicraft making done in chain-of-custody certified factories which export the rattan products to European countries	2006-2010	Villages in Khamkeut District, Bolikhamxay province.
	Certification of rattan management areas	Certification of rattan management areas by FSC with total area of 1,142 ha.	2011 - date	

Dyes

Country	Name of technology	Brief description	Year of development	Adopters/Users of technology
Processing/Product Development				
Philippines	Natural dyes extraction and textile application	Environment-friendly process of extracting dyes from indigenous plant sources from 75 plants like indigo, annatto, mahogany, sibukaw producing a wide range of colors and applied to natural fibers, yarns and fabrics	1995	Weavers (private sector)
	Dye powder production of natural powder extracts	Involves conversion of crude extracts into powder, which has longer shelf-life and has more versatile applications in textile dyeing and printing	2004	Private companies
	Silk screen printing using natural dyes	Preparation of the natural dye into printing paste suitable for silk screen printing	2006	Entrepreneurs

Plant fibers

Country	Name of technology	Brief description	Year of development	Adopters/Users of technology
Processing/Product Development				
Philippines	Bleaching and dyeing of indigenous fibers	involves pretreatment, scouring and/or bleaching followed by dyeing using prescribed dyestuff of particular fibers which enhance aesthetic appeal and improve the quality of indigenous fibers for handicrafts	1985	Private Entrepreneurs
	Tie-dyeing	dyeing techniques involves tying or stitching a string into the fabric to keep the dye from being absorbed into the material, creating various designs and patterns depending on how the fabric is tied; process is repeated many times by making new knots in other parts of the cloth and immersing the fabric in additional dyebaths	-	Private entrepreneurs
	Pinukpok processing	woven abaca or pineapple fiber is chemically treated followed by mechanical softening by pressing with a motorized rotary press to impart the desired flattened, supple and compact appearance	1998	SMEs, cooperatives, weavers in Albay, Zamboanga del Sur, Leyte
	Rotary press for mechanized rotary pressing	machine facilitates chemical softening and subsequent mechanical pressing of indigenous fabrics to desired softness, smoothness and luster; machine assures faster and better quality of finished material	2003	SMEs, cooperatives, associations in different regions
	Various handloom weaving	Weaving techniques that enable the use of abaca, pineapple, buntal, raffia for the production of hand-		Weavers' association, handicraft manufacturers

	techniques	woven fabrics, with various designs		
	Double sley mechanism for handloom weaving	Consists of a picking mechanism where standard fly-shuttle beater is combined with an additional shuttle box in the middle of the beater; Two separate warps are set and gaited in the loom and two shuttles can be thrown simultaneously with a single activation of the picker, making it possible to produce two cloth simultaneously with perfect selvedge on both sides of each fabric, increasing production by 100%	2005	Housewives, out-of-school youths, cooperatives, associations
	enhanced handloom weaving technology through design innovation	produces fabric with various weave design, through the use of a loom with 4-harnes and using yarns of different sizes, colors and properties, and of different materials, imparting aesthetic appeal and adding value to handloom woven products	1994	Private entrepreneur
	Pretreatment technology of indigenous fibers (abaca, banana, pineapple, maguey and water hyacinth)	Pre-treatment involves degumming using mechanical and chemical treatment of the extracted fibers, to modify inherent hardness and remove high non-fibrous content, to prepare the fibers for the process requirements for textile production; may or may not be aided with microbiological treatment	1990	Private textile milling plants; entrepreneurs

Medicinal Plants/Herbs

Country	Name of technology	Brief description	Year of development	Adopters/Users of technology
Innovating processing technologies/ systems and product development				
Malaysia	Plant secondary metabolites from plant herbs	Extraction, isolation & identification of bioactive from plant secondary metabolites	1995	Herbal product manufacturer / entrepreneurs
	Bioactives (from secondary metabolites) for selected therapeutic uses	(i) Prospecting for bioactives with selected properties (anti-microbe, anti-oxidant, anti-inflammatory, anti-diabetic, anti-proliferative, mosquito repellant, larvicidal) (ii) Efficacy evaluation for selected product formulation (e.g., disinfectant, insect repellant)	1995	Herbal product manufacturer / entrepreneurs
	Plant authentication technologies of herbal/aromatic plants	Identification and authentication of plant samples via morphological characterization & chemical fingerprint (selected species)	1995	Academia, herbal entrepreneurs
	Essential oil distillation & extraction technology of aromatic plants	Extraction, isolation and profiling of essential oil from aromatic plants	1995	Herbal entrepreneurs (esp. Toiletries / Perfumeries related products)

Various non-wood materials

Country	**Name of technology**	**Brief description**	**Year of development**	**Adopters/Users of technology**
Innovating processing technologies/ systems and product development				
Cambodia	Sustainable Product Innovation (SPIN)	Promotes sustainable design in term of planet, people and profit: mainly focused on food processing sector, furniture and handicraft	2010	Demo companies
	Cleaner Production	Minimized wastes at sources in product manufacturing	2005	Demo companies
	Residue or waste (biomass) utilization	Converting waste agricultural biomass to energy	2012	Still under field assessment
	Fruit wine from Wild Grapes	Probably for the first time, Cambodia wild grapes (local name: Tompeng Baychhou Prey) are used to produce fruit wine on a commercial scale	2010	•Wild Grape Association • Pursat c/o Mr. NOU Virak • Krobao Prum Tep Agriculture Development Cooperative (109 members) Kulen District, Preah Vihear Province Contact Person: Mr. Thon San, President
Malaysia	Biodiesel from non-edible forest materials	Production of biodiesel for non-food resources	2011	Under development
Philippines	Finishing Spray Booth	An enclosure that controls the spread of excess spray during the finishing operation. Controls air pollution in the factory	Year 1990s	Manufacturers of Furniture and handicrafts

	Handmade Paper Making	Crafted from fibrous agro-forest materials such as rice straw, abaca wastes, maguey, banana trunk, cogon grass, water lily, sugarcane bagasse & waste papers	1990s	
	Reinforcement fibers from abaca wastes	Strengthen old cartons for liner board and corrugating medium	2007	Alindeco (pulp making company)
Collection and harvesting systems				
Laos	Collection and processing of various forest plants/non-timber products	Seasonal collection/ harvesting and processing of: Broom grass, tiger grass (*Thysanoleana maxima*) which is then sold to middleman for export to Thailand	Many years ago	Provinces at the central and northern parts of Laos
		Seasonal collection and processing of: ເຄືອແຫມ (Haem) *Coscinium fenestratum* and *Fibraurea recisa,* which are then sold to middleman, locally processed with some being exported to Thailand, China & Vietnam	Many years ago	Provinces at the central and southern parts of Laos
		Seasonal collection of ໝາກແໜ່ງ (Mak Naeng) (*Amomum microcarpum*) which are then sold to middleman and exported to Thailand, China	Many years ago	Almost whole areas of the country (in natural high forest)
		Collection of ປໍສາ (Porsa)Paper mulberry (*Morus papyrifera*) which are sold to middleman and exported to Thailand	Many years ago	Almost whole areas of the country (river Sides/moisture areas)
Development of Knowledge systems				
Philippines	Compilation of potential tree species as alternative sources of biofuels	Compilation of seed oil producing tree species to serve as guide in the identification of potential sources of biofuel	2009-2010	Researchers, farmers, LGUs, academe

Appendix Table L Addendum. Institutions that filled out the survey questionnaires/matrices.

Name of Institution	Address/Country	Head of Institution	Person who accomplished form
National Cleaner Production Office-Cambodia (NCPO)	Ministry of Industry, Mines and Energy #45, Norodom Blvd. Khan Daun Penh, Phnom Penh, Cambodia	VA Chanmakaravuth, Director	SRENG Sokvung , CP/SPIN expert

Cambodian Organic Agricultural Association (COrAA)	# 44A, Street 320, Sangkat Boeung Keng Kang III, Khan Chamkar Mon, Phnom Penh	CHHIM Phallyboth , Program Coordinator	
Forest Research Institute Malaysia (FRIM)	52109 Kepong, Selangor D.E., Malaysia	Dato'Dr. Abdul Latif Mohmod, Director General	Dr Mastura Mohtar , Senior Research Officer, Natural Products Division Dr Hamdan Hussein Head, Wood Quality & Non-Forest Products
Department of Forestry (DOF)	Thatdam area, Chanthabuly District, Vientiane Capital, Lao PDR	Dr. Silavanh Sawatvong (DG) Mr. Khamphay Manivong (DDG)	Phomma Pathoummavong Forest Certification Coordinator
Forest Products Research and Development Institute (FPRDI)	College, Laguna, Philippines	Dr. Romulo T. Aggangan, Director	
Ecosystems Research and Development Bureau (ERDB)	College, Laguna, Philippines	Forester Marcial C. Amaro, Jr. Immediate Past Director replaced by Dr. Portia G. Lapitan, OIC-Director (2013)	Gina C. Tocino Science Research Specialist I
Philippine Textile Research Institute (PTRI)	Gen. Santos Ave., Bicutan, Taguig City, Metro Manila, Philippines	Dr. Carlos C. Tomboc, Director	Rowena M.R. Evidor Planning Officer III

Appendix Table M. Interviewees and their affiliations (by country).

Country	Date	Name of interviewee/Person Met	Position/Organization
Malaysia	October 15, 2012	Ms. Joana de Rozario	Country representative, NTFP-EP Malaysia

		Dr. Sim Heok Choh	Executive Director, APAFRI
		Dr. Pin Ka Yeng	Herbal Technology Centre, Natural Products Div., FRIM
	October 16, 2012	Dr. Mohd Shahwahid Othman	Dean, Faculty of Economics & Mgmt, UPM
		Dr. Rahim Sudin	Director, Forest Products Div., FRIM
		Dr. Mastura Mohtar	Senior Research Officer, Bioactivity Programme, Natural Products Div., FRIM
		Dr. Lim Hin Fui	Senior Researcher, FRIM
	October 17, 2012	Dr. Jegatheswaran Ratnasingam	Profesor Madya, Fakulti Perhutanan, Universiti Putra Malaysia

Lao PDR	Date	Name of interviewee/Person Met	Organization
	October 22, 2012	Whilley Lelis	Technical Advisor, Ministry of Agriculture & Forestry
		Phomma Pathoummavong	Forest Certification Coordinator, Department of Forestry
		Manuel Bonita	Consultant
		Sengrath	
		Joost Foppes	Consultant, formerly with SNV
	Oct 23, 2012	Buakhai Phimmavong	Managing Partner/Consultant, Enterprise & Dev’t Consultants Co., Ltd.
		Ed Canela	Consultant
		Bouvanh Phachomphonh	Project Manager – Rattan, WWF-Laos
		Louise Carlsson	Forest Project Coordinator , WWF-Laos
		Le Viet Tam	Regional Sustainable Rattan Project Manager, WWF-Laos
	Oct 24, 2012	Mr. Phouvong Phommabout	DDG, Ministry of Industry and Commerce
		Mr. Somvixay Vongtharrath	Deputy Director of Division, Trade Promotion Development
		Ms. Phonesy Silarvanh	Officer of Product Development
		Ms. Thongsavath Boupha	Country officer, RECOFTC-Laos
		Sounthone Ketphanh	D. Director of Forestry Research Center, Nat’l Agriculture and Forestry Research Institute
		Mr. Lamphoune Xayvongsa	Faculty of Forestry, National University of Laos

		Dr. Somvang Phimmavong	Lecturer, Faculty of Forestry, Dongdok
		Khamphay Manivong	Deputy Director General, Ministry of Agriculture and Forestry, Dept. of Forestry
		Christopher Flint	CTA/Team Leader, The Agro-Biodiversity Initiative (TABI)

Cambodia	**Date**	**Name of interviewee/Person Met**	**Organization**
	Oct 27	Khou Eang Hourt	National Community Forestry Expert/Team Leader, Enhancing Community-Based Forest Management and Utilization for the Improvement of Rural Livelihoods in Cambodia
		Femy Pinto	Coordinator, NTFP-EP Cambodia
		Phan Channa	Administrative Officer, NTFP-EP Cambodia
	Oct 28	Trip to Kratie	
	Oct 29	Visit to Leaf drying factory/fiber production village	Say Cheas Comune, Svay Cheas Village, Kratie
	Oct 30	Dr. Sreng Sokvung	Cleaner Production Expert, National Cleaner Production Office - Cambodia
		Engr. Chong Bou	Deputy Chief of Industrial Safety Office, Dept. of Industrial Techniques
		Mithona	CoRAA
	Oct 31	Ledecq Thibault	Conservation Programme Manager, WWF Cambodia
		Uch Sophay	Marketing Officer, NatureWild
		Lip Cheang	Chief of Rattan Association of Cambodia
	Nov 1	Neil Patterson	Knowledge Management Advisor, Volunteer Service Overseas
		Von Monin	Dean of Forestry Faculty, Royal University of Agriculture
		Chrun Rithy	Lecturer, Faculty of Agro-Industry
		Ek Sopheap	Vice Dean, Faculty of Agro-Industry
	Nov 2	Lang Seng Horn	Khmer Agricultural Trade Alliance (KATA) Co., Ltd.

		Lun Yeng	Executive Director, Federation of Associations for Small and Medium Enterprises of Cambodia, FASMEC
		Heang Sarim	Cambodia NTFP Dev't Organization, CANDO

Indonesia	**Date**	**Name of interviewee/Person Met**	**Organization**
	November 12, 2012 (Monday)	Dr. Dede Rohadi	Deputy Director, R&D Center on Plantation Forests, Forestry Research and Development Agency (FORDA)
		Sofwan Bustomi	Researcher, Centre for Forest Productivity Research and Dev't.
		Dr. Maman Turjaman	Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam
		Desy Ekawati	Div of Follow up Research and Cooperation, FORDA
		Ludvi Abdula	
		Jatnika	Yayasan Bambu Indonesia
	November 13, 2012 (Tuesday)	Ramadhani Achdiawan	Statistician, Forests & Livelihood Programme, CIFOR
		Ani Adiwinata Nawir	Socio-Economics Scientist, CIFOR
		James Roshetko	Leader, Trees and Market Unit Southeast Asia, World Agroforestry Centre
		Dr. Naresworo Nugroho	Vice Dean, Faculty of Forestry, Bogor Agricultural University
		Dr. Rita Kartika Sari	Professor
		Dr. Yusuf Sudohadi	Former Dean
		H. Ervizal A.M. Zuhud	Professor, Forest and Human Health, Div. of Plants Biodiversity Conservation, Dept. of Forest Resources Conservation, Faculty of Forestry, Bogor Agricultural University
	November 14, 2012 (Wednesday)	JT	Former Staff, ICRAF and Research Officer, NTFP-EP Indonesia
		Sagita	ASFN

			Ministry of Forestry, Manggala
		Eri Indransan	Deputy for Planning, Directorate of Social Forestry, Ministry of Forestry
	November 15, 2012 (Thursday)	Johnny W. Utama	Member, NTFP-EP Indonesia Board
		Nuning S. Barwa	Member, NTFP-EP Indonesia Board and Corporate Social Responsibility Director, Martha Tilaar Group of Companies; President, Indonesian Cosmetic Association
	November 16, 2012 (Friday)	Ir. Heru D. Wardana	Community Dev't., Martha Tilaar Group
		Visited Martha Tilaar garden and manufacturing plant	

Myanmar	**Date**	**Name of interviewee/Person Met**	**Organization**
	Nov 26, 2012 (Mon)	Win Myo Thu	Managing Director, Ecodev
		Aung Ko Thet	Program Officer, Ecodev
		Tony Neil	Consultant, Ecodev
		Ohn Lwin	Professor, Forest Products Dept., University of Forestry
	Nov 27, 2012 (Tue)	Bobby Mg	Chief Executive Officer, Network Activities Group
		Gerry Fox	Team Leader, Pyoe Pin Programme, DFID-SIDA
		Salai Cung Lian Thawng	Strategic Adviser, Pyoe Pin Programme, DFID-SIDA
	Nov 28, 2012 (Wed)	Travel to Nay Pyi Taw	
	Nov 29, 2012 (Thu)	Zaw Win Myint	Director, Forest Research Institute
		Khin May Lwin	Research Officer, Forest Industries Section, Forest Research Institute
		Yi Yi Han	Asst Director, Wood Utilization Div., Forest Research Institute
		U Kyaw Win Maung	Assistant Research Officer, Wood Anatomy Section, Forest Research Institute

		Aye Chan Maung	Range Officer, Forest Research Institute
		Maung Maung Than	Training & Research Dev't Div., Ministry of Environmental Conservation & Forestry
	Nov 30, 2012	Return travel to Yangon	
		Ohmar Kaing	Coordinator, Food Security Working Group

Philippines	Date	Name of interviewee/Person Met	Organization
	Dec 13, 2012	Jenne H de Beer	Former Executive Director, NTFP-EP