Sixteen Lao agrobiodiversity products with high potential for food security and income generation

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Swiss Agency for Development and Cooperation SDC

Imprint

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Concept and technical edition
Dr Liliane Ortega, Chris Flint

English version editor
Marianne Gadeberg

Design
Tanakit ARUNYANAK, 3D Trading sole co.,ltd

Photographs
Cover Front/Back: Toula/SDC Mekong; page 10, 12, 14, 16, 18, 21, 23, 25, 27, 29, 32, 34, 36, 38, 40, 42: TABI

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Vientiane, 2016

ACRONYMS

CCL	Comité de Coopération avec le Laos
CDE	Center for Development and Environment
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
DAEC	Department of Agriculture Extension and Cooperatives
FSC	Forest Stewardship Council
GRET	Professionals for Fair Development
HH	household
IFAD	International Fund for Agriculture Development
MAF	Ministry of Agriculture and Forestry
NAFRI	National Agriculture and Forestry Institute
NTFP	Non-timber forest product
NUDP	Northern Upland Development Project
PAFO	Province Agriculture and Forestry Office
RECOFTC	The Center for People and Forest
SADU	Smallholder Agricultural-market Development in the Uplands of Lao PDR
SNV	Netherlands Development Organization
TABI	The Agrobiodiversity Initiative
WWF	World Wildlife Fund

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FOREWORD

Being a center of origin for glutinous rice and harboring the largest reservoir of forest resources in Southeast Asia, Lao PDR is a global biodiversity hotspot. The national economy heavily depends on natural resources since a large part of the population relies on shifting cultivation, cultivating a broad range of local rice and other crop varieties and collecting and using an exceptional diversity of natural plants and animals from the farm landscape and surrounding forest areas. While these natural resources are the basis of Lao PDR's biodiversity wealth, they are also fragile, especially in the mountainous northern region. This area is made up of slopes with thin soils prone to erosion, and it is inhabited by various culturally diverse ethnic groups. They are among the poorest segments of the population, and they rely on these diverse agriculture systems, which are gradually being replaced by extensive commercial plantations.

All Lao farm families rely on agrobiodiversity resources for food, income, material, fiber and medicine. Ethnic minorities that live in rural upland areas and practice shifting agriculture are the most dependent upon agrobiodiversity resources, which often account for their main source of food, income and material subsistence needs. They have a high level of knowledge of the biodiversity resources available to them. Under low population pressure, these traditional systems result in sustainable supplies of agrobiodiversity resources.

A combination of an increased population, increasing dependence on a market economy, intensified agriculture systems and a growing demand and market for biodiversity products, mostly from outside, has put excessive pressure on agrobiodiversity resources, leading to habitat destruction and over-harvesting. These issues, combined with a lack of biodiversity management options, are resulting in the loss of important biodiversity resources.

Agrobiodiversity cuts across and connects the issues of markets, nutrition, farming systems, poverty, land use, and information and education needs. Income and food from the collection of naturally occurring plants and animals represent the cornerstone of livelihood strategies. Upland farmers depend upon wood, fibers and resin products from the farm and surrounding areas for their supply of everyday needs for shelter, equipment, tools and handicrafts. Farmers are collecting and domesticating naturally occurring species to take advantage of evolving market opportunities and to supplement subsistence farming. The environmental and ecological services provided by biodiversity are the foundation for the sustainable cultivation of all crops, for domestic consumption and for subsistence as well as high productivity farming systems that supply local, regional and international markets.

SDC's involvement in agriculture and food security has provided a good basis for linking the various factors impacting agrobiodiversity, e.g., links between land access, land allocation, agro systems, resettlement, traditional farming systems, education, health and poverty, food security, biodiversity resources and multilateral environment agreements. It also offers opportunities for improved evidence-based policy at multiple levels and across multiple sectors. With The Agrobiodiversity Initiative (TABI), SDC and the Ministry of Agriculture and Forestry (MAF) are addressing the promotion of agrobiodiversity for food security and income generation in Lao PDR. A fundamental output of TABI is a better understanding of the specific threats to agrobiodiversity in various agro-ecological zones, the various uses of agrobiodiversity within upland communities and the consequences of ongoing social, ecological and environmental change.

This study on agrobiodiversity products aims to inform Lao decision makers and the public that despite serious decline due to overexploitation and loss of natural habitats, some agrobiodiversity products still have an important potential for development through domestication and sustainable use. Export markets for unique Lao crops like the Kao Kai Noi or mountain wild teas, as well as community-based agro-tourism promoting the Lao ancestral knowhow, can be a chance for preserving the beauty and quality of Lao agro-ecosystems.

With this report, Lao decision makers will be able to have a clear idea that Lao agrobiodiversity has the ***potential of improving local economy through enhancing the livelihood of hundreds of upland families, and at the same time creating an international reputation for Lao unique products.***

INTRODUCTION by the authors

The main purpose of this capitalization process is to review the present knowledge on selected agrobiodiversity products and draw lessons from experiences while providing data, key facts and recommendations for pro-poor and sustainable use of each resource.

The central part of this document is the profiles of – or fact sheets on – 16 agrobiodiversity products. Each agrobiodiversity product is presented via a standard two-page format. Each fact sheet is limited to a brief overview of a product. For more information on each product, the reader is kindly invited to refer to the list of consulted references presented at the end of the document. Most of the references are available in PDF from the authors of this compilation.

The reader is kindly reminded that the ***present fact sheets should not be considered a final product:*** they are working documents that may be further modified, illustrated, edited and translated into Lao by SDC. As presented here, the 16 agrobiodiversity products are not ranked in any particular order.

Each fact sheet contains the following standard sections: (1) **production types:** product key features, key definitions and how it is produced; (2) **current production:** relative importance, how much and where it is produced; (3) **production, consumption and sales:** income generation aspects illustrated by examples; (4) **processing:** (key points only) major steps involved, potential for added value within Lao PDR, quality issues; (5) **marketing:** trading channels, market demands, grading systems, domestic and foreign demands; (6) **constraints:** main bottlenecks for sustainable exploitation and pro-poor development; (7) **potentials:** opportunities for further development; (8) **summary:** concluding remarks and main recommendations.

Section 8, the summary, aims to offer the readers, especially the decision makers, a very brief section with key insights and recommendations for each product. The authors hope that these concluding remarks will help the busy reader quickly grasp the essential facts about each product.

A few issues that are common to most agrobiodiversity products are worth emphasizing here because they are not systematically mentioned in the fact sheets: (1) **Statistics.** There is a general need for more accurate statistics on production, domestic and export trade for most agrobiodiversity products, in order to establish sustainable quotas for collectors, buyers and exporters. (2) **Informal/illegal trade** (traders operating without license) is negatively affecting the sustainability and the quality of several products while also weakening the position of legal traders. (3) **Organizational aspects.** To develop sustainable value chains for agrobiodiversity products it is important to also support the establishment of appropriate **farmers' organizations** (production groups, marketing groups, etc.). (4) **Climate change and agrobiodiversity.** There is a growing consensus on perceiving agrobiodiversity as an important asset for mitigating climate change. For example, product diversification and use of plants with high carbon sequestration capacity, such as bamboos, are among the strategic options.

ACKNOWLEDGEMENTS

The two authors wish to express their gratitude to all the organizations and individuals who have kindly provided information and contributed with various ideas and guidance during the preparation of these 16 profiles. The main organizations and resource persons include the following: Dr. Liliane Ortega, SDC Vientiane office; Mr. Pheng Souvanthong and Mr. Chris Flint, TABI Coordination Unit at MAF (who also provided logistical support and access to the huge amount of data from sub-projects in Luang Prabang, Xieng Khouang and Huaphan provinces); Mrs. Cornelia Hett, Centre for Development and Environment team collaborating with TABI on statistics and maps; Mr. Ole Pedersen, GEF/UNDP/FAO/ MAF Agro-Biodiversity Project; Mrs Bouavanh, WWF Laos (Rattan project); Mr. Jean-François Kibler, GRET (Bamboo project in Huaphan province), Mr. Francis Chagnaud, Agroforex Company (benzoin rehabilitation and development in Huaphan, Phongsaly and Luang Prabang provinces); CCL (livelihood project including cardamom in Gnot Ou, Phongsaly province); Mr. Rakesh Munankami, Helvetas-Swiss-Intercooperation (shan tea project in Phongsaly province); Mr. Matthieu Segard for facilitating access to the NUDP studies on broom grass and cardamom. At NAFRI: Dr. Chay Bounphanousay, Rice Research Center (for Khao Kai Noi); Mr. Soulivanthong Kinkeo, (for fish conservation zones); Mr. Soukan Keonouchan, Livestock Research Center (for native chickens and pigs). At DAEC: Dr. Sengpaseuth Rasasombath, (for Khao Kai Noi); at PAFO Xieng Khouang: Mr. Malaypeth (for bee keeping); at PAFO Huaphan: Mr. Siviengxam, (for fish in rice fields). The authors are also grateful to Jean-François Castella (CIRAD); Rik Delnoye (IFAD); Jonas Noven (NIRAS); Carl Mossberg; Jost Foppes; and Michael Jones.

Various other individual resource persons and specialists have also formally or informally contributed with information, comments and ideas. Thank you all for your kind collaboration!

LITTLE CHICKEN RICE (Khao Kai Noi)

PRODUCTION TYPE

Khao Kai Noi (KKN or "Little Chicken Rice") is a wet-season traditional glutinous rice variety of the northern upland paddy fields produced under rain-fed conditions. Lao PDR is known for its huge rice diversity and also for being in the region generally accepted as the area of origin and domestication of the Asiatic rice (Oryza sativa). It is also believed to be the center of origin for glutinous or waxy rice. People of Huaphan and Xieng Khouang provinces have a particularly strong cultural affinity with the KKN glutinous rice variety, of which the grain is strikingly different from that of most other varieties, being short, rounded and nearly globular in shape. It is generally grown in highland paddies with very little purchased inputs.

KKN has several unique characteristics: (1) excellent eating quality (sometimes consumed without side dishes), (2) high milling recovery of 80% compared with 65% for most other varieties, (3) photoperiod-sensitive and late maturing, but non-shattering variety, (4) well yielding under low input conditions with up to 3-4 tons/ha, (5) grown as a lowland rain-fed variety at high altitude (more than 800 meters above sea level), and (6) has up to nine variant forms, based on glume color and other characteristics, with yellow KKN being the most widely used form in Huaphan and Xieng Khouang provinces.

Since KKN is a traditional late maturing rice variety, its response to modern inputs such as inorganic fertilizers is limited, but it is well adapted to low-input conditions or non-monetary inputs such as compost and manure.

CURRENT PRODUCTION

According to a recent TABI-supported survey, KKN is mainly confined to districts located at high altitude in both Huaphan and Xieng Khouang provinces. In the 2013 wet season, the total area under KKN cultivation was 13,338 ha, with a total production of 43,504 tons (average yield of 3.2 tons/ha).

Huaphan province had a total KKN area of 6,061 ha, producing 18,048 tons in 2013 (average yield of 3 tons/ha). It is worth noting that 99% and 96% of lowland rain-fed rice areas were planted with KKN in the districts of Viengxay and Xamneua, respectively. In 2013, Xieng Khouang province had planted 7,277 ha, producing 25,456 tons (average yield of 3.5 tons/ha), mainly in the plateau districts, i.e., Pek, Khoun, Phaxay and Phoukoud. KKN occupied more than 70% of the total lowland rain-fed rice area in these four districts.

PRODUCTION, CONSUMPTION AND SALES

The KKN variety represents a valuable source of food and a significant source of income. For example, two KKN production schemes monitored in selected villages of Xieng Khouang have resulted in the following data for the wet season of 2013:

A group of 64 households (HHs) in 3 villages produced 137.5 tons from 42 ha with an average yield of 3.2 tons/ha. They consumed 73%, kept 4% as seed stock and sold 23%. Selling generated 125 million kips with an average income of **2 million kips/HH** (equivalent to **about 240 USD/HH**).

Another group of 100 HHs in 6 villages organically produced 239.8 tons from 63 ha, with an average yield of 3.8 tons/ha. They consumed 84%, kept 2% for seed stock and sold 14% of the total, generating 136 million kips, with an average income of **1.4 million kips/HH** (equivalent to **about 167 USD/HH**).

PROCESSING

More than 90% of the KKN rice is consumed in the form of steamed rice, but there are also various other forms of glutinous rice-based preparations, such as rice noodles, rice cakes, and fermented beverages such as rice wine, rice brandy, and sweet fermented rice. Recently the Lao Brewery Company started using KKN for making the Beer Lao Gold brand. As a result, the Lao Brewery Company has sponsored the first Khao Kai Noi festival in December 2014 in Xieng Khouang.

MARKETING

About 90% and 70% of the production are consumed by producers in Huaphan and Xieng Khouang provinces, respectively. Due to a high demand and a low supply of KKN there is generally no problem selling KKN, but Vietnamese markets have recently diminished due to poor quality milling of KKN. About 70 tons are annually exported to Vietnam, and additional amounts are exported to China. Xieng Khouang province is listing KKN as a top export product. KKN is also exported to France (known as "riz petit poussin du Laos") and Japan. Recently, Xieng Khouang agreed to supply 40 tons of KKN per month to the Lao Brewery Company for making the Beer Lao Gold brand.

CONSTRAINTS

The major constraints to the production of high-quality KKN are (1) limited suitable areas at high altitude for possible expansion (KKN can be planted in the lower plains, but the quality is very inferior), (2) the KKN rice variety cannot be grown during the dry season with irrigation because it is a photoperiod-sensitive rice variety and always flowering and fruiting during the same month of the year regardless of when it is sown, (3) mechanization is limited to very small areas, (4) lack of a systematic and good quality seed supply, (5) climate change affecting traditional drying methods, and (5) poor milling facilities resulting in a lower quality product.

POTENTIALS

In the short term, the production of high-quality seed, the introduction of small farm machinery, the application of good agricultural practices (organic or smart agriculture), and improved harvesting and drying techniques should be promoted.

In the medium term, KKN can and should be formally protected by geographical indication. In the long term, the creation of new KKN-based rice varieties could be carried out to widen the ecological plasticity of the KKN variety. NAFRI is now crossing KKN and Do Nang Nuane (a traditional glutinous aromatic rice variety of the lowland plains).

SUMMARY

The wet-season traditional glutinous Khao Kai Noi variety is an important representative of the paddy rice diversity in the northern Lao uplands. It is highly demanded – regionally – as a source of food. It is also a source of income. It is linked to traditions, culture and tourism. It is mostly consumed within Lao PDR and partially exported. However, its potential for further expansion outside Xieng Khouang and Huaphan provinces is limited by the lack of suitable agro-ecological conditions. And thus development efforts should be focused on yield and especially quality, cultivars and marketing aspects, with the aim to increase net returns and income to producers.

BAMBOOS

PRODUCTION TYPES

Bamboos are fast growing species exploited through two production types: (1) **natural forests and** (2) **cultivated bamboos** (plantations and bamboo gardens). There are two categories of bamboo products: (1) ***bamboo canes and*** (2) ***bamboo shoots.*** Bamboo canes are processed for making a wide range of products: construction materials, household items, handicrafts, incense sticks, etc. Bamboo shoots are processed for food. Bamboo products are either locally consumed or exported.

Bamboos are important for the economic and cultural life of Lao villagers and are often perceived as the most economically important NTFP. A total of 52 species from 15 genera have been documented from different forest types all over the country.

CURRENT PRODUCTION

Statistics on annual production of bamboo canes and bamboo shoots in Lao PDR are not available. There are about 6,000 square kilometers of bamboo forests across Lao PDR. Bamboo areas are probably increasing due to deforestation in semi-evergreen and mixed deciduous forest habitats. The mountainous northern part of Lao PDR is one of the richest areas for bamboos. Surveys show it holds at least 50 species, and in Xieng Khouang and Huaphan provinces there are 30 species that differ from those in central and southern Lao PDR. *Dendrocalamus, Cephalostachyum* and *Oxytenanthera* are the dominant bamboo genera. Bamboos are also good for carbon sequestration and thus interesting for climate change mitigation.

Bamboo production may be interrupted by flowering: many species flower every 15 or 30 years, while others, such as *Dendrocalamus,* bloom after 70 years. Entire bamboo stands will die after flowering, before regenerating from seeds.

PRODUCTION, CONSUMPTION AND SALES

An example of ***cane bamboo*** from TABI in Luang Prabang could be summarized as follows: In 2013-2014 a total of 397 HHs harvested 170,800 kg of cane bamboo from 32 ha. They sold 82% and consumed 18%. Total income was 559 million kips representing an average income of 1.4 million kips/HH (equivalent to **about 173 USD/HH**).

Another example of ***cane bamboo*** from the GRET/SNV experience in Huaphan province is summarized as follows: In 2013, 458 HHs from 34 villages made and sold bamboo handicraft products to 11 traders or directly in trade fairs,

generating a total income of 950 million kips, meaning an average of 2.1 million kips per HH (equivalent to **about 255 USD/HH**).

An example of ***bamboo shoots*** from TABI SPA 002 in Xieng Khouang generated the following data: Among 212 HHs from 8 villages, 84 HHs produced 485 cans filled with bamboo shoots of the "Nor Lai" species. They sold 472 cans for a price varying between 70,000 and 100,000 kips/can, and they consumed 13 cans. Total income was 41 million kips, corresponding to an average income of 488,571 kips/HH (equivalent to **about 60 USD/HH**).

Another example with ***bamboo shoots*** from the GRET/SNV experience in Huaphan province is summarized as follows: During the season Dec 2012-March 203, 336 HHs from 37 villages harvested and sold 210 tons of fresh shoots to 12 traders and collectors, generating a total income of 587 million kips with an average income of 1.7 million kips per HH (equivalent to **about 205 USD/HH**).

PROCESSING

Cane bamboo can be processed into construction materials, handicraft, sticks and household items. The steps involved during processing of cane bamboo depend on the final product. Canes are also used as bamboo poles. Industrial cane processing is still very small in Lao PDR.

Edible bamboo shoots are first peeled, and then further processed by the addition of salt or by being boiled and then sometimes sun or oven dried, or fermented. These processes allow shoots to be preserved for up to a year. Canned shoots are always pre-boiled. The Lao shoot processing industry is still very limited.

MARKETING

The world market for bamboo cane products is huge. In 2012, the INBAR (International Network on Bamboo and Rattan, Beijing) produced a report on the international trade of bamboo and rattan. It describes the trade trend of bamboo products as ever increasing. In Lao PDR, various bamboo cane products are sold domestically and increasing amounts are exported. There is also a significant market for bamboo shoots in Lao PDR (mainly fresh shoots), with some being exported (mainly processed shoots).

CONSTRAINTS

The main constraints for developing a bamboo industry in Lao PDR are (1) limited know-how in sustainable bamboo resource management and poor market information, (2) no clear policies to support the development of a bamboo industry, (3) unfinished land use and land allocation with unclear forest and bamboo management policies not allowing protection and efficient harvesting of existing bamboo stands, (4) present tax policies are perceived to have a negative effect on the development of the bamboo industry.

POTENTIALS

The main potentials for developing a bamboo industry in Lao PDR are (1) abundant bamboo resources in Lao PDR, (2) expanding global market with bamboo becoming a practical substitute for timber-based products, (3) growing demands for bamboo products in neighboring countries such as Vietnam, (4) undeveloped domestic Lao market with opportunities for expansion, (5) age-old traditional skills in bamboo craft in various parts of Lao PDR, (6) environmental benefits of bamboo for soils (it has double the carbon sequestration capacity compared to other plants), and (7) the Huaphan bamboo project, technically assisted by GRET and SNV, and the Bokeo bamboo supply efficiency project, supported by RECOFTC, offer some lessons learned for possible replications elsewhere.

SUMMARY

Bamboo is an important biodiversity resource of Lao PDR. It plays a key role in the social and economic life of rural communities, contributing to cash income, food security and livelihood. It also plays a vital environmental role on soils through carbon sequestration. The ongoing expansion of the global bamboo industry offers an opportunity to fully develop a Lao bamboo industry. The Huaphan bamboo development strategy, developed and implemented by villagers, government and private sector, should serve as a model for replication and adaptation in other regions of Lao PDR, with three key components: sustainable resource management, bamboo business development and favorable bamboo policies to promote the development and growth of the bamboo sector. The Bokeo bamboo project should also be considered as a model for lessons learned on supply efficiency.

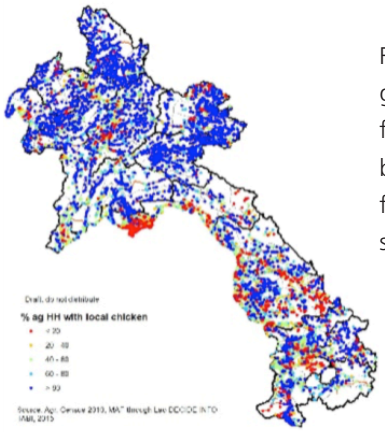
NATIVE CHICKENS AND PIGS

PRODUCTION TYPES

With their excellent adaptation to the traditional local conditions, Lao native chickens and pigs have long been playing an important role in the livelihoods of farm households in rural areas. Lao native pigs belong to the species Sus domesticus with four types ("Moo Lat", "Moo Hmong", "Moo Jid", "Moo Berk"), whereas Lao native chickens belong to the sub-species Gallus gallus domesticus with five breeds ("Kai Yok", "Kai Che", "Kai Horn Chook", "Kai Dook Dam", "Kai Ou"). More than 90% of Lao chicken and pig raisers use native breeds.

Four types of production systems are generally distinguished between for small livestock: (1) ***extensive,*** fully free range, (2) ***semi-extensive,*** free range by day, in pen by night with some supplementary feed, (3) ***semi-intensive,*** enclosure area with more supplementary feed, and (4) ***intensive,*** in pen with adequate feed. Most of the Lao native chicken and pig production systems fall within the first or second system with some on the third system and rarely on the intensive system.

Distribution map of native chicken in Lao PDR 2010/11 (Map by: Cornelia Hett, CDE-TABI)



CURRENT PRODUCTION

According to the 2010/11 agriculture census, farm households raising native chickens accounted for about 62%, or 486,500 HHs, with a total number of 8,664,900 chicken. This represents a reduction of 700,000 HH compared to the figures from 1999 when they represented 73%. Pig raising households (90% use native breeds) accounted for 306,400 HH (there were 327,500 HH in 1999), with a total number of 978,300 heads (there were 1,036,300 heads in 1999).

The results of the agriculture census 2010/11 indicate that, compared to 1999, the numbers of native chickens and pigs have, despite of their tasty meat, higher price and higher popularity than the exotic breeds for local consumption, decreased by 10%, along with the number of small livestock raisers,.

PRODUCTION, CONSUMPTION AND SALES

For ***chicken raising,*** a first example from TABI SPA 015 in Xieng Khouang in 22 villages show that total annual income for 158 HHs selling 2,606 chicken (out of 10,179 chicken) was 106,266,000 kips, corresponding to an average income of **672,569 kips/HH.** This is equivalent to about 80 USD/HH and represents an average unit price of 40,777 kips/chicken, equivalent to about 5 USD/chicken.

For ***pig raising,*** a second example from TABI SPA 062 in Luang Prabang in 6 villages show that total income for 44 HHs selling 284 pigs (out of 528 pigs) was 184 million kips. This represented an average income of **4.2 million kips/HH** (equivalent to **about 506 USD/HH**) with an average unit price of 650,740 kips/pig (equivalent to **about 78 USD/pig**).

PROCESSING

In rural areas, meat from small livestock is generally used as unprocessed ingredient for cooking. A wide range of dishes, be it traditional or international, can be made from native chicken and pigs. They are often used in specific ceremonies, such as "baci," and other rituals. The black bone chicken ("Kai Dook Dam") is highly demanded for making a famous delicacy soup. Preliminary experiments in 2007 and 2008 suggested that meat and fat ingredients and intramuscular fat content in the native pig "Moo Lat" are similar to those of the world famous Hungarian "Mangalica" and Spanish "Iberico" breeds. This is an advantage and opportunity to promote the Lao native pigs. Those pigs and chickens from Lao PDR that are exported as living animals, not meat.

MARKETING

The Lao native chicken has a strong position in local markets. Its price is about 30% higher than that of common broilers, possibly because of its limited production and high popularity. On the other hand, the rapid increase of exotic pig population is signaling a real danger for native pigs. Modern, highly intensive large-scale farms are booming in most big cities with high competition between multinational firms. However, increased export of native chickens and pigs to Vietnam has been confirmed by local authorities.

CONSTRAINTS

At production level, the major constraints are (1) lack of breeding management due to free range production systems, (2) disease epidemics such as bird flu, Newcastle disease, hog cholera, swine fever, (3) lack of good quality feed and feeding practices, mainly in the dry season, (4) lack of suitable management with high mortality rate among chicks and piglets.

Regarding the production environment, constraints are (1) lack of clear supportive policy at macro-level, such as registration of raisers or farms, (2) lack of strict regulation on illegal import of exotic pigs and chicken, (3) no proper farmer organization and access to credit at the micro level, (4) lack of strong extension network, (5) stiff competition with exotic modern farms.

POTENTIAL

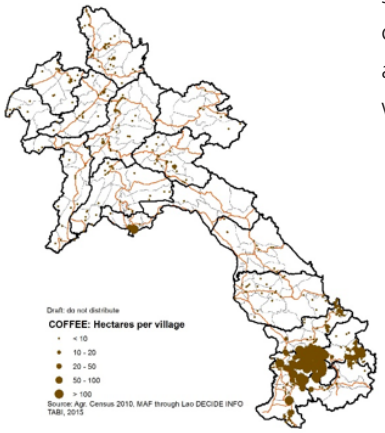
Low growth rate and high mortality of native chicks and piglets of native chickens and pigs are mainly due to food restriction and lack of good management rather than their growth potential. Therefore, there is an ample room for a qualitative improvement of the production. More than 50% of total farm households are already engaged in small livestock production, so research and development on native chickens and pigs should urgently be undertaken in a systematic manner.

SUMMARY

Native chickens and pigs are widespread in rural Lao PDR. They represent both a source of food and income and are used for rituals. Women are often more involved in small livestock activities. The number of raisers and scale of production are declining, partly due to competition with exotic breeds and changes in rural villages. But native breeds are still in high demand, and management (feed, health & techniques) and policy environment (regulations) should be improved.

COFFEE IN NORTHERN UPLANDS

Distribution map of coffee areas in Lao PDR, 2011 (Map designed by Cornelia Hett).



PRODUCTION TYPES

Coffee production in the northern Lao uplands is relatively new when compared to the southern region of the Boloven Plateau where the first coffee plantations were established around 1920 by French settlers. Until now, Lao coffee comes mostly from the south. The northern uplands mainly use Arabica Catimor cultivars of Coffea arabica, introduced in Lao PDR during the nineties. Most of the coffee plantations in the northern uplands belong to smallholders and represent two production types: (1) shade-grown coffee, of which some is under forest canopy that gives an excellent cupping quality and an eco-friendly product and (2) sun coffee cultivation, without shade trees.

CURRENT PRODUCTION

In 2011, the coffee area in the Boloven Plateau was more than 70,000 ha, equivalent to 95% of the total coffee area of the country. In the northern region, the provinces of Phongsaly, Luang Prabang, Xieng Khouang and Huaphan accounted for 470 ha, 1,733 ha, 283 ha and 43 ha, respectively. Average yields were 500-700 kg/ha of green beans. Coffee cultivation in Phongsaly province is rapidly increasing, to substitute opium growing, on a contract farming–basis involving some Chinese investors.

PRODUCTION, CONSUMPTION AND SALES

Lao farmers grow coffee to generate income from sales and not for their own consumption.

Based on an experience of shade-grown coffee in Keoset area, Khoun district, Xieng Khouang province, where coffee cultivation was supported by IFAD in 2001, rehabilitated and revived by SADU in 2009 and then extended by TABI in 2014, the costs and benefits of shade-grown coffee under forest can be summarized as follows:

Establishment activities. Labor (person/day) per ha: land clearing 15, digging holes 20, planting 20, replanting 5. Total labor: 60 man-days x 50,000 kips = 3,000,000 kips. Inputs: seedlings (2,500 plants x 5,000 kips = 1,250,000 kips), farm manure 300,000 kips, transport 200,000 kips total: 1,750,000 kips. Total establishment costs = 4,750,000 kips/ha. This

plantation lasts for more than 30 years (depreciation = 150,000 kips/year). ***Maintenance/recurrent activities*** (weeding, liming, pruning, pest control): 2,500,000 kips/year. ***Harvesting and wet processing*** (9,000 kg red cherry/ha): cherry picking costs = 150 man-days x 50,000 kip = 7,500,000 kips; wet processing costs = 1,000 kips/kg x 1,500 green beans = 1,500,000 kips. Total harvesting costs: 9,000,000 kips/year. Total production costs = 150,000 + 2,500,000 + 9,000,000 kips = 11,650,000 kips. Income: 1,500 kg x 20,000 kips/kg = 30,000,000 kips. Profit (or gross margin): 30,000,000 – 11,650,000 = 18,356,000 kips/ha/year. (N.B.: labor requirements are mostly met by family labor, with the exception of harvesting, which requires one or two additional laborers for one month).

PROCESSING

Coffee processing at farm level starts right after harvesting, using the dry or the wet method. Coffee roasting takes place outside farms in specialized processing units, usually within Lao PDR. **Dry method:** This processing method is mainly used with Robusta coffee in the south, and the resulting product gets a lower price than coffee produced through the **wet method** due to inferior taste. Wet method: Lao farmers generally use the wet method to process Arabica coffee. Once an Arabica cherry is picked, it must be pulped within 24 hours to avoid rot. Then soaking, washing, sun drying and finally hulling takes place to get green beans. This method is quite complicated but adds some value (more than 10%) compared to selling red cherries directly as in the case of Luang Prabang. It also involves communal activities, including sharing the small processing plant.

MARKETING

Lao PDR is a coffee producing and exporting country, but a minor player in the international market, and yet, it is able to produce high-quality, organic coffee. This suggests that the northern upland coffee will need to explore options for growth within niches and specialty markets, which large volume producers have generally been slow to exploit (perhaps not for too much longer). Currently, niche markets can be categorized into four distinct market areas, namely (a) **gourmet/rare,** (b) **organic,** (c) **shade-grown,** and (d) **fair trade.** Taking into consideration the current production methods used in Lao PDR, northern coffee farmers have the potential to qualify for organic, shade-grown and fair trade status.

CONSTRAINTS

The major constraints to the development of coffee production in the northern uplands can be summarized as follows: (1) difficult access with winding roads in mountainous environment, (2) limited flat or moderately sloping land, (3) need for quality improvement and recognition, including GI, (4) land management issues, and (6) limited labor availability during the harvesting season. Growing more and more Arabica catimor has an impact on water use and environment pollution.

POTENTIALS

There is potential to produce more coffee in the Northern region to respond to the increasing demands from China, from foreign tourists, etc. Various lessons could be easily drawn from the long experiences of coffee development on the Boloven plateau combined with the eco-friendly approaches used by some coffee projects in the North. Considering the external factors related to coffee production, the Northern uplands have the potential to adopt some appropriate agro-forestry approaches, involving various forms of shade-coffee cultivation systems, in order to minimize the possible adverse impacts on the local forests and biodiversity.

SUMMARY

From a geographical point of view, and according to the national coffee strategy, the development of eco-friendly coffee cultivation in the northern region should be considered, but on a more "opportunistic" basis, conditioned by the existence of marketing opportunities or by the private sector. More studies on markets and on technical approaches limiting the biodiversity losses in the new area where coffee is being grown are needed to avoid economic and environmental risks.

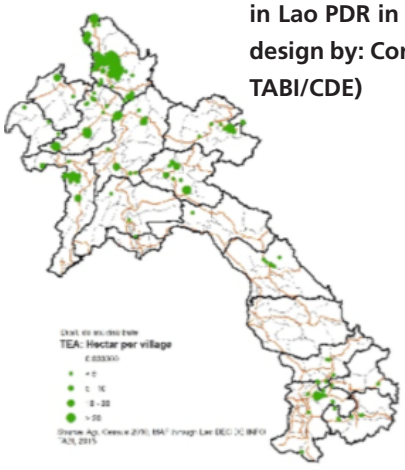
TEA IN NORTHERN UPLANDS

PRODUCTION TYPES

There are three general tea production types in Lao PDR: (1) **Wild** or forest tea, which has various sub-types of production, (2) **ancient tea,** or old cultivated trees that were often planted more than one hundred years ago (for example the Komen tea in Phongsaly), and (3) **cultivated tea gardens,** based on either locally domesticated cultivars or on tea cultivars introduced more recently for commercial production to reduce shifting cultivation and opium production. The tea price generally decreases from type 1 to 3, while productivity per hectare increases. While tea researchers in China identified sub-species in Lao PDR as "Camellia sealyama," the landrace of tea mostly exploited in Lao PDR is probably Camellia sinensis var. assamica (a broad-leafed variety used for making "Puer" tea as opposed to the narrow-leafed tea Camellia sinensis var. sinensis and other types). Tea found in Lao PDR is also good for making black tea and green tea. Northern Lao PDR is part of the center of origin for tea, and new species or varieties may be discovered among the wild tea forests located on several "tea mountains".

CURRENT PRODUCTION

Tea production is concentrated in northern Lao PDR, where more than 85% of production takes place, with 60% in Phongsaly district alone. Tea is produced by highland ethnic minorities in Phongsaly, Sayaboury, Bokeo, Luang Namtha, Oudomxay, Xieng Khouang and Huaphan provinces. In 2009, total production was about 1,000 tons with estimated value of 3.5-4.5 million USD, and in 2012 there was 3,975 tons. Women are generally more involved in picking and drying tea leaves than men.



Distribution map of tea in Lao PDR in 2010 (Map design by: Cornelia Hett, TABI/CDE)

PRODUCTION, SALES AND INCOME

Data from TABI in Nambak district, Luang Prabang province, involving 397 HHs from 3 villages, of which 55 HHs harvested some tea, resulted in the following in 2013-2014: there were 7 ha of natural tea with 2,500 plants and also 52 ha of tea gardens with 72,000 plants. They harvested about 50,000 kg of which they sold 46,500 kg (= 93%) and consumed 3,500 kg (= 7%). Total income was 550 Million kips for 55 HHs, corresponding to an ***average of 10 million kips/HH*** (equivalent to ***about 1250 USD/HH***). Average unit price was 16,745 kips/kg (dried leaves) equivalent to about 2 USD/kg.

PROCESSING

Tea can be harvested almost throughout the year, but the best-quality tea is picked at the beginning of cool period. Fresh leaves can be processed into a variety of different teas soon after picking or the following if the farmers wither it properly. This makes on-site processing essential. Processing steps vary with the desired end product, i.e., whether one is producing green tea, red tea, "Maocha" (a rough tea to make Puer tea), etc. Some basic steps may include (depending on the desired end product): (1) picking/plucking leaves, (2) withering (to reduce humidity in the leaves), (3) wok-pan roasting (called "kill green"), (4) rolling, (5) oxidation, (6) drying, (7) sorting and grading, (8) storage and packaging. The primary product in northern Lao PDR is often called Maocha, but there is increasing production of red and green teas. While some farmers process tea into Maocha, others sell fresh tea to local factories located in Phongsaly, Oudomxay, Xieng Khouang, etc.

MARKETING

Tea is the most important beverage in the world after water. Though it is not a popular drink in Lao PDR, tea is very important in China and Vietnam where there is an ever-growing market. The Lao tea is mainly exported to China (Yunnan) and other destinations. The tea usually sold in Lao PDR is either processed tea from Vietnam. More recently, a trend of greater consumption of Lao tea has emerged.

Tea's value is determined by its appearance, taste, color and aroma, all of which depend on type of tea, altitude, ecosystem and soil, timing of pick, processing quality, and storage. The intrinsically high quality of Lao highland old teas means that they are capable of potentially generating high sales prices. Yunnan remains the principal market, absorbing at least 90% of the Lao tea production, but the Lao tea is obtaining lower prices than the Chinese teas due to poorer processing quality, trade barriers and Chinese import taxes.

CONSTRAINTS

The main constraints for developing a tea sub-sector are (1) limited understanding of wild tea potential and insufficient botanical surveys, (2) limited skills for processing tea to ensure quality, (3) high dependency on Chinese market with limited linkages to other markets, (4) degradation of old tea resources through swidden, felling for tea collection, agroforestry plantations and sale of ancient trees, (5) lack of national support programs for the tea sub-sector (as for coffee), (6) cheap tea imports from neighboring countries,. Also, wild tea forests in Yunnan are now protected from exploitation due to their scarcity and their high genetic value. As a result, the pressure to exploit the unprotected Lao wild tea forests is increasing.

POTENTIAL

There is scope for better quantitative and qualitative production of tea through a combination of better management techniques and expansion of cultivated areas. The main potential for sustainable development of the Lao tea sub-sector include the following: (1) existing tea resources in several regions, (2) low labor cost, (3) increasing private sector engagement and investment, (4) growing links with the tea market in China, (5) growing potential for organic certification, (6) high-value niche for wild and ancient tea, (7) easy access to China and Vietnam for technical training, (8) a trend of high consumption of Lao tea in many places.

SUMMARY

Lao PDR can further develop a small, but geographically broad, organic tea industry based primarily upon ancient and wild tea types. Wild tea forests are under threat; they must be inventoried and sustainably managed. More research and specialized training is also required. Lao PDR should not seek to compete in global low-value bulk tea markets, but instead focus on niche tea products.

BENZOIN

PRODUCTION TYPES

Lao benzoin is a balsamic resin obtained from tapping the ***Styrax tonkinensis,*** a fast-growing tree that naturally grows in mountainous regions of northern Lao PDR, northern Vietnam and southern China. Two production types are distinguished: (1) ***naturally growing benzoin trees*** (in upland fallows after rice) and (2) ***cultivated benzoin trees*** (in fallows or elsewhere). In general, cultivated benzoin trees are more and more common. Yields and quality depend on altitude and soil. Lao benzoin is the oldest internationally traded product from Lao PDR, mainly known as "Siam benzoin," as opposed to the Sumatra benzoin produced from two other species. Its production had been declining over the years, but it has been increasing again over the last decade. The Lao benzoin is considered by some high-end perfume manufacturers in Europe as the best one for the perfume industry. It is also used for medicines and incense.

Traditionally, ***Styrax tonkinensis*** has been well integrated into shifting cultivation systems with fallows of at least 10-12 years, with benzoin trees being the main fast-growing trees in fallows after growing upland rice. The shortening of fallow periods has created more difficult conditions for growing and exploiting benzoin trees in fallows.

CURRENT PRODUCTION

The total annual production in Lao PDR is estimated to be about 70-90 tons, mainly concentrated in Huaphan, Phongsaly and Luang Prabang provinces where benzoin trees generally grow at 800-1,600 meters above sea level. The total area where benzoin grows is estimated to cover more than 10,000 ha (not in pure stands, but mixed with other plants). Small amounts are possibly also produced in Oudomxay and Luang Namtha provinces. It is believed that about 170 villages are involved in benzoin production. Reported yields vary between 160kg/ha and 240 kg/ha (assuming 400 trees per hectare). Tapping involves bark incisions and generally takes place when trees are 5-7 year old and lasts for 4-7 years. Yields vary with age. Tapping of trees takes place in September-November. Collection of resin (= benzoin gum) takes place in February-March after the resin dries and becomes harder and fragile during the cooler winter season. Tapping and harvesting is men's work, while cleaning and sorting is mainly done by women. Benzoin gum is mainly collected by the poorest ethnic minority highland farmers (Khamu, Laopong, etc.). Trees are individually owned.

PRODUCTION, CONSUMPTION AND SALES

Benzoin is produced by farmers mainly for sale (small amounts might still be used for traditional medicines). Each tree is capable of producing between 300 gr. and 1 kg of benzoin gum. Availability of a male labor force is important. There may be 300 trees per hectare, but only about 50 trees would be selected for tapping. They are selected at the end of the rainy season. On average, one man can tap 30 to 50 trees per day. Farm gate prices varied between 50,000 and 90,000 kips per kg in 2014. In Luang Prabang (Phonthong district) a total of 182 HHs from 4 villages were able to generate 766 million kips of income from benzoin sales from 319 ha with 332 benzoin tree plots. This corresponded to an average income of **4.2 million kips /HH** (equivalent to **about 516 USD/HH**).

PROCESSING

The processing steps depend on the final product. Farmers are not involved in processing: They only separate the bark and other impurities from the resin "tears", store the product in jute sacks and then sell it to traders. ***The first processing step*** (mainly cleaning and grading) is performed in Lao PDR by the exporting company, without using solvents following the international standard requirements for the pharmaceutical and flavoring industries. ***The second processing step,*** which requires the use of solvents, is mainly performed in Europe, above all in France, where a dozen of enterprises are specialized in extracting the benzoin resinoid, the "absolute" benzoin, the benzoin tincture, etc. Then some of it is further used in Switzerland, mainly as a fixative of flavor, for making several high-end perfumes. The Lao benzoin is also used as an active compound for making pharmaceutical products in Europe.

MARKETING

Only a small share of the Lao benzoin produced is used in Lao PDR (about 11-15%), mainly for incense. Due to its high quality, compared to the more common Sumatra benzoin (obtained from different tree species), about 85% of the Lao production is exported. The product has several niche markets in Europe where it has been renowned for centuries. The Agroforex Company is the main buyer and exporter of benzoin in Lao PDR and has developed a sustainable business model, also promoting the quality of the Lao benzoin on the international market. Benzoin grades are mainly based on size and color. Higher grade is obtained from the largest pieces. Lower grade corresponds to smaller pieces. The benzoin gum is a fragile product that usually breaks into smaller pieces during transportation, resulting in quality loss.

CONSTRAINTS

The main constraints could be summarized as follows: (1) shortening fallow periods for growing benzoin trees, (2) damage by uncontrolled free-grazing animals, (3) raw benzoin demanded only by a few traders who can then dictate their prices, (4) presence of informal traders (operating without license) who distort the market, encourage corruption and impact quality and tax collection, (5) benzoin production is potentially threatened by rural exodus, by the expansion of cash crops in northern Lao PDR (rubber, coffee, tea, etc.) and by synthetic benzoin to a lesser extent.

POTENTIAL

Potential to further develop the Lao benzoin production are mainly limited to some villages of three provinces: Luang Prabang, Phongsaly and Huaphan. Priority should be given to sustainability and rehabilitation of the existing production. Main potentials include (1) Styrax tonkinensis is a fast-growing multipurpose tree (also cultivated for pulpwood in Vietnam and for firewood in China), (2) Lao benzoin is renowned for its top quality by the perfume industry and the pharmaceutical industry, (3) Lao benzoin is sold as a certified organic product on some international markets, (4) tappers have considerable traditional experience with benzoin, which is well known in upland communities and its production has high acceptance, (5) the benzoin rehabilitation program led by the Agroforex Company can serve as a model for further expansion, and (6) thanks to the efforts of Agroforex, Lao benzoin has been approved in 2014 as a food flavor under the name *"Benzoe tonkinensis"* (by the WHO/FAO joint commission for the *Codex Alimentarius*), which leads to potential use in many more countries.

SUMMARY

Until recent years, low price and competition with other forest products were considered the main causes for the overall decline of the Lao benzoin production. Over the past decades, production has been increasing again through rehabilitation of village benzoin forests, with the help of the private sector. Benzoin production is geographically concentrated in three Northern provinces (Huaphan, Phongsaly and Luang Prabang). The benzoin value chain is complex, and its sustainability partially relies on a combination of long-term business and social interventions from different stakeholders.

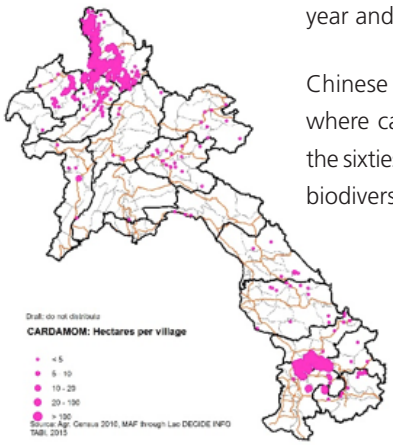
CARDAMOM

PRODUCTION TYPES

Cardamom is mainly found in upland agroforestry systems. Two types are exploited by farmers: (1) ***wild cardamom*** collected from the forest (several species), and (2) ***cultivated cardamom*** (mainly two varieties: one from China and one from Paksong). The Lao cardamom is only produced for export. The Chinese "Khouang Tung" variety, a cultivated medicinal cardamom introduced in Lao PDR in the nineties, with the botanical name *Amomum villosum* var. *xanthoides,* is presently the most popular among farmers. The "Paksong" variety is also cultivated by some farmers. The Khouang Tung variety requires more shade than the Paksong variety, and it grows well at altitudes higher than 800 meters above sea level with rainfall of 1,200-2,400 mm. It can be harvested after 3 years. Yield increases until the 10th year and then decreases.

Chinese studies in neighboring Yunnan Province, where cardamom has been widely cultivated since the sixties, have demonstrated that it decreases forest biodiversity. In Lao PDR, the native wild cardamoms are becoming rarer, while the cultivated types are gaining importance due to more demand and higher price.

Cardamom distribution in Lao PDR for 2011, in hectares per village, (Map designed by Cornelia Hett).



CURRENT PRODUCTION

Wild cardamom exists in various humid secondary forests throughout the country, while cultivated cardamom is concentrated in regions close to the Lao-Chinese borders and around the Boloven plateau. In 2010/11, the total cardamom area was 6,426 ha for 660 villages involving 13,252 HHs. Distribution by province was 2,180 ha in Phongsaly (= 34%), 1,500 ha in Xekong (= 23%), 1,324 ha in Champassack (= 20%), 814 ha in Saravane (= 12 %), 251 ha in Oudomxay (= 4 %), 234 ha in Luang Namtha (= 3 %), 73 ha in Attapeu (1 %) and the remaining 3% elsewhere

Access rules differ by type: wild cardamom can be freely collected by any villager (with risk of over-harvesting), while cultivated cardamom belongs to the cultivating household. Cultivated cardamom requires suitable land, land rights, seedlings and availability of labor. Farmers may produce and sell both types. Wild cardamom is generally more associated with the poorest, landless households.

PRODUCTION, CONSUMPTION AND SALES

Cardamom is produced for sale, not for local consumption. Cultivated cardamom requires limited work: Initial weeding, clearing and harvesting require less than 50 workdays per ha with an additional 5 days for drying. Production levels vary with years. One hectare produces from 20 to 750 kg dried fruits depending mostly on pollination but also on age, shade, humidity, fertility and the timing of the rainy season. In 2014, dried cardamom was sold

by Phongsaly farmers for 410,000–448,000 kips/kg (= USD 40/kg), providing about 36,500,000 kips of incomes per HH. Fresh cardamom price was 63,000–66,500 kips/kg.

PROCESSING

Cardamom fruits are not processed in Lao PDR. They are only dried after harvest by the farmers themselves or by buyers. Cardamom is either sun dried, dried over wood fires or dried in ovens. Ovens are often required because harvesting takes place during the wet season. Cardamom needs 4-5 hours to dry in an oven, but slower and longer for better quality. Fruits need to be dried evenly to give even quality. When well dried, 15 kg of fresh cardamom fruits results in 3 kg of dry fruits. Storage is in a ventilated room. If kept in glass jars, dried cardamom pods can be stored indefinitely. In China, the fruit is processed into essential oils, and in Thailand seed oil is obtained by water distillation. It is unclear at this stage if there are possibilities for processing cardamom in Lao PDR before export.

MARKETING

The main market for medicinal cardamom is China where it is used for making traditional medicines against digestive troubles. Demand in China was already estimated at 2,000 tons per year in 2001, and non-decorticated cardamom was sold for a price of 5.00–7.00 USD per kg in Yunnan. Grading is based on size of fruits or cluster of seeds; amount of immature and overripe fruits; and amount of molding, dirt and unwanted plant material. On global markets, Lao cardamom is known as "black cardamom" by opposition to "green cardamom" from India, Guatemala, etc. that is imported in Europe for the food industry. Thai traders tolerate a mold rate of 3% of the fruits. There are three grades for seeds: (1) matured blue-black seeds, (2) over-matured black seeds, and (3) broken seeds. Fruits must be dry, clean and still in the capsules to preserve taste. Prices are constantly fluctuating, but the Khouang Tung cultivated variety is usually generating three to four times more income than the wild cardamom varieties.

CONSTRAINTS

There are a few constraints for further expanding cultivated cardamom: (1) it cannot be grown at high elevations; it usually grows at 600-1,000 meters above sea level, (2) land ownership must be ensured for village communities to invest in cardamom production within communal forests, (3) it cannot be grown by poorer landless villagers except if planted in communal forest zones, (4) yield varies from year to year, (5) harvesting and drying take place in the rainy season (July-August) with possible problems of mold, (6) market prices are fluctuating in spite of an increasing demand from China, (7) product quality and trade are constrained by informal traders who operate without licenses. For native wild cardamom species the most important problem is the loss of natural forest habitats through conversion into permanent plantations (rubber, coffee, etc.), which is depleting the resource.

POTENTIAL

Wild and cultivated cardamoms have the advantage of being easily integrated into local agroforestry systems because they require about 50% of shade. Potential for further development exists, due to (1) good demand for medicinal cardamom in China, (2) high regard among farmers, who usually like cultivating cardamom because it generates substantial income and it is easily adopted as a new crop, (3) limited labor inputs after the initial establishment of the crop (mainly for weeding and harvesting), (4) being a low-volume, high-value product, (5) the only requirement being cash for purchasing seedlings, (6) inorganic fertilizers and pesticides not being required, making it an organic product.

SUMMARY

During the past decades, the cultivated medicinal cardamom introduced from China has overtaken the importance of the native wild cardamom, following higher international demands. The Lao cardamom is produced for export and is processed outside Lao PDR. It generates more and more income for farmers, and it is easy to spread. However, widespread cultivation of cardamom decreases forest biodiversity (according to Chinese studies). The status of wild cardamom needs to be monitored because of the reduction of natural forests resulting in loss of appropriate habitat. Since cardamom is cultivated in communal forests, the land ownership for cardamom production should be recognized at community level and not at household level.

cies with multiple stems regenerate reasonably well, every three to five years, but knowledge of this process is still limited. Over-harvesting of clustering species inhibits the formation of new clumps, and taking too many young canes lowers the economic productivity.

RATTAN

PRODUCTION TYPES

Two main production types are distinguished: (1) **wild rattan,** mainly producing **cane rattan** that is collected from the forest, essentially for export, and (2) **cultivated rattan,** with production of edible shoots mainly for the domestic market (only a few species are domesticated and cultivated). Edible rattan shoots can be harvested within two years after planting, whereas rattan for cane production takes at least six to seven years. Rattans are climbing palms of **two types:** solitary rattans (with only one stem) and clustering rattans (with several stems).

At least 31 rattan species have been identified in Lao PDR, whose six species are of high value: *Calamus poilanei (Wai Thoun), C. nambariensis (Wai niew), C. gracilis (Wai hom), C. palustris (Wai am hang), C. viminalis (Wai khom)* and *C. solitarius (Wai thok).* Rattan cane is mainly used for furniture and handicraft. The most important large-diameter rattan species for cane production in Lao PDR is *Calamus poilanei* ("Wai thoun" in Lao), while the most cultivated species for edible shoots is the small-diameter species *Calamus tenuis* ("Wai nyeh" in Lao). Some species are exploited for both canes and shoots.

Traditional harvesting practices are destructive, as both mature and immature stems are cut. Only mature stems of age 5-20 years bear fruits, so natural regeneration is restricted. Reproduction is especially poor for solitary rattans as the shoots can only be harvested once and then the plant dies. Clustering spe-

CURRENT PRODUCTION

A lot of rattan cane has been exported from Lao PDR during the past thirty years, mostly to Vietnam, China and Thailand, generating much income at different levels, though the amounts involved are difficult to quantify with precision because of a general lack of official statistics. What is certain is that wild stocks of rattan have been declining throughout Lao PDR and Southeast Asia due to deforestation and excessive exploitation. Some species are now threatened, prompting initiatives to domesticate and cultivate rattan.

PRODUCTION, CONSUMPTION AND SALES

Rattan shoots. The example of TABI SPA 12 from 7 villages in Phoukoud district, Xieng Khouang, can be summarized as follows: 116 HH planted 19,652 rattan plants on 9.1 ha. They produced 4,939 shoots of which 3,241 shoots (66%) were sold, and 1,698 shoots (34%) were consumed. Total income was 10.4 million kips, corresponding to an average of 62,852 kips/HH (equivalent to 7.7 USD/HH). Average unit price was 3,220 kips/shoot (about 0.4 USD/shoot).

PROCESSING

Rattan canes. Once the canes are harvested and debarked, they are sold directly or indirectly to a factory. Furniture factories boil rattan canes in a diesel solution for 45-60 minutes at 60-150 0C to remove moisture, waxy materials, resins and gums and to improve color and prevent insect or fungi attack. After boiling, the canes are washed with pressured water or scrubbed with sawdust or sun dried for 2-3 weeks to remove the remaining dirt and diesel. Sulphur is used

to provide a uniform color, while stains are removed by a bleaching solution with various chemicals. The canes are then air dried for a period of 50-60 days, then straightened and tied into sorted and graded bundles. Canes are heated by steam before they are bent into desired shapes in molds for manufacturing furniture and handicraft products.

Rattan shoots. When shoots are prepared for eating, the spiny bark is removed and the inner core of the plant is cooked. Rattan tastes like bamboo shoots, but rather bitter. Fresh shoots for eating can be kept for several days. For preservation, shoots are boiled or steamed, and then sun dried. Seven to eight kilos of fresh shoots (200 shoots) give about 1 kg of dried rattan shoots.

MARKETING

Rattan canes. Factories or middlemen buy canes from farmers for about 0.1-0.3 USD per kg for small canes or 0.65-8 USD for five-meter canes (3 mm diameter). Quality criteria: Small-diameter rattans are under 3 cm. If bigger, they are classified as large diameter. Grading is based on defects, which can be minimized by keeping canes off the ground because ground storage can lead to fungal infections and damage by dirt. Rattan baskets have been exported to Switzerland over the past years. The Swiss retailer is regularly sending request for more.

Rattan shoots. Edible shoots are consumed locally or exported to Southeast Asian communities in France, the United States and elsewhere. Locally, a single rattan shoot is sold for 0.05–0.3 USD. Dry shoots of Calamus tenuis (Wai nyeh) are worth up to 100 USD per kg in USA.

CONTRAINTS

In spite of the progress made in rattan research, more needs to be researched, including more botanical studies, knowledge on species growth and more accurate assessments of existing wild rattan resources. Some main general constraints still remain: (1) continuous deforestation and loss of habitat, (2) overharvesting practices, (3) harvesting and trade quotas are generally based on market demand and not on sustainable management practices.

POTENTIAL

Rattan knowledge in Lao PDR has progressed a lot during the past twenty years, with research work by NAFRI (with support from Kew Botanical Gardens, UK). All this work provides a sound base for further initiatives aiming at sustainable exploitation of rattan resources. Identification of most species was done with a field guide, which has been produced in both Lao and English versions, in addition to various other studies. Since 1994, rattan cultivation for edible shoot production has been progressively introduced in various villages of the country to reach about 300 ha in 2012. A pilot project on sustainable management and fair trading practices is underway with WWF technical advice, enabling Lao PDR to become the first country with FSC-certified rattan from forest.

SUMMARY

During the past thirty years, wild rattan resources have been declining in Lao PDR due to an export-driven over-exploitation and deforestation. With more than 31 rattan species already discovered during the last two decades, Lao PDR has an impressive rattan diversity that is used for producing canes and edible shoots. However, several species are endangered. More and more rattan is being cultivated to produce edible shoots, and this should be further encouraged. The sustainable rattan harvesting and production project supported by IKEA and SDC through WWF during the last decade provide a good model of a rattan supply chain from sustainable rattan forest management by using FSC (Forest Stewardship Council) certification model until selling the product. This model can be adapted and replicated elsewhere.

BROOM GRASS

PRODUCTION TYPES

Broom grass *(Thysanolaena maxima)*, known in Lao PDR as "Dok Khem", is a **naturally growing,** semi-domesticated NTFP found in upland fallows, degraded forests and degraded land along roads and villages. In addition to a cutting implement, it mainly requires labor for harvesting, drying and threshing the inflorescences, which are the plant parts eventually used to make brooms. The harvesting period lasts for approximately two months, and, depending on regional conditions, harvest occurs between late December and March.

Broom grass is **also cultivated** as a crop in some villages. When cultivated, it is less time consuming than other field crops. Weeds need to be pulled out and then cut back once annually. In addition, harvesting from a field is easier than harvesting from the forest, mainly because of the increased density of plants in a planted field. Farmers can plant rooting stems in year 1 and harvest through year 4, burn the plants and begin the process again the following year. Yield is estimated to be 1 ton/ha of dried and threshed inflorescences.

It is also reported that a new variety of broom grass has been introduced, showing yields of 2-3 tons/ha, but it seems to be a variety more suitable for irrigated land than upland fallow land.

CURRENT PRODUCTION

Exact volumes of production are not known because official statistics are limited. However, data from some provinces give an indication of the volumes exported: In 2011, it was reported that broom grass export from Oudomxay amounted to 51.5 tons to China, 7 tons to Vietnam and 8,235 tons to Thailand.

CONSUMPTION AND SALES

It was reported that back in 1999, a family with all members working full time on broom grass could generate an income of about 1,200 USD per year, but this could be an exceptional case. According to a recent study in Muang Khoa (Phongsaly), ***income from gathering broom grass varies between 0.5 million kips and 1.7 million kips per HH.*** The same study estimated that, if cultivated, the average profit per hectare could vary between 2.3 million kips and 13.3 million kips/ha, with corresponding average yields of 800 kg/ha and 1,500 kg/ha, respectively. The average price for dry broom grass flowers was reported to be 5,000 kips/kg.

PROCESSING

After harvesting, the flowers of the broom grass are sun dried for three to five days. The seeds are removed by manual threshing, and the grass stems are bundled for storage until it is time to sell them to traders or for broom making. The stems are bound together to form the broom handles, which may also sometimes be made from thin bamboo canes. It is estimated that one kilogram of flowering grass can produce two brooms. And one person can make five to ten brooms per day, and they can be stored several years. Broom making takes place in Lao PDR or outside Lao PDR (in Thailand, China and Vietnam). Broom grass can also be used to make paintbrushes. Regarding quality criteria, long, full flowers are preferred, and they should be clean and not damaged.

MARKETING

There is both a domestic market and an export market for broom grass. There is a continuous market demand, and large quantities of unprocessed dry flowers are annually exported to Thailand, China and Vietnam. Some of the brooms made in Thailand are further exported to Japan.

CONSTRAINTS

The main constraints for broom grass can be summarized as follows: (1) provincial production and export records are generally inadequate and inaccurate, (2) the lack of coordinated collection & distribution process limits village authorities to manage transactions between villagers and traders, (4) there are no grading systems or standards for differentiating the product, (5) difficult road access for more remote and vulnerable populations may reduce the price traders are willing to pay, and (6) villagers have limited skills and techniques to make brooms in their own villages and thus limited ability to add value from on-farm processing and marketing.

POTENTIAL

The main potentials for broom grass production are the following: (1) relatively stable prices, (2) broom grass grows naturally in fallow land, degraded land, along roads and around villages, (3) it is simply harvested and requires minimal inputs, (4) broom grass can be cultivated, (5) for villages along main roads, transportation to foreign markets is relatively easy (China, Thailand and Vietnam), and (6) potential exists for making brooms within villages, and, alternatively, a commercial broom factory could be established.

SUMMARY

Broom grass is a product generally found throughout the upland areas of the country where it is relatively common on degraded land and fallows. It is a source of income for poor farmers and also a source of animal feed. Large quantities of unprocessed broom grass are exported. Broom grass harvesting and drying occupy and provide income to many farmer families, however the added value is mostly abroad. Efforts should be made to encourage more processing in Lao PDR, based on further studies of the broom grass value chain. Broom grass is one of the few agrobiodiversity products that are not under threat from over-exploitation.

CRISPY RIVER WEED

PRODUCTION TYPES

Crispy river weed, or "Khai pean," sheets are made from dried freshwater macro-algae garnished with salt, sesame and other ingredients. This product is consumed as a snack or delicacy food, which is very popular in Luang Prabang, the world heritage city, both consumed locally and purchased by regional tourists. Product quality depends partly on the species of algae involved and its natural ecology. There are at least seven species of macro-algae that can be found in the Mekong River and surrounding streams, mainly belonging to the genus *Cladophora* and *Microspora*. However, around 60% of all "khai paen" sold in Luang Prabang is estimated to be derived from *Cladophora glomerata* or "Khai Meun", "Khai Mai." Other species or varieties are of lower quality.

These fresh-river algae are a natural and essential part of the ecosystem, growing under water on rocks. They thrive in clear spots of running water in the Mekong River and other streams. In these habitats, the algae sit at the base of the aquatic food chain. Small freshwater crustaceans, small fishes and other small animals consume these algae and are in turn consumed by larger animals.

CURRENT PRODUCTION

Algae collection and consumption of fresh algae is fairly widespread throughout the country, but the preparation into dried sheets is more limited, and this "Khai paen" production is found only in the northern region, particularly in the Mekong River, and in catchments such as that of the Nam Khan River (which covers Huaphan, Xiengkhouang and Luang Prabang) and Nam Ou River (Phongsaly, Oudomxay and Luang Prabang). Quantities produced vary from place to place. According to some preliminary information, villages in the upper Nam Khan can get only 5 tons of fresh algae per year per village, whereas downstream, near Luang Prabang, they are able to collect 500-800 tons per year per village. According to a study by Xaoban and Lao Women's Union in Luang Prabang in 2011, four villages with 486 households produced 9.5 million sheets, equivalent to 1,900 tons of fresh algae.

PRODUCTION, CONSUMPTION AND SALES

The Lao Women's Union of Luang Prabang interviewed "khai paen" producers to estimate the income derived from this livelihood activity. The number of sheets varied between 15,000 and 30,000 sheets per household per year. ***The average gross income from selling "khai paen" was 28.7 million kips (about 3,589 USD) per household, varying from 6 to 60 million kips (750–3,030 USD) per household*** per year. The total sales of "khai paen" in four villages amounted to 140 billion kips (17,469,000 USD) for 2011. The main costs involved in processing the algae into sheets were material costs (sesame, herbal dressing equipment, etc.) and labor costs. With a selling price of 2,000 kips per sheet, material costs represented only 17% of the price. Labor inputs were calculated based on observations and interviews with villagers. A household of four persons can spend 7-10 hours producing 75 sheets from 15 kg of algae per day. The returns per labor-day vary from 58,600 kips to 76,600 kips (7.32–9.58 USD). That compares favorably to the average official labor rate of 50,000 kips (6.25 USD) per day.

PROCESSING

Steps in making "khai paen" sheets include the following: ***Step 1 – Collecting.*** Producers usually go to collect fresh river algae in the early morning or buy from collectors. ***Step 2 – Washing and beating.*** Collected fresh weeds are washed on a large rock or cement platform and then rinsed several times to remove sand. ***Step 3 – Draining.*** Algae are hung in the shade to drain the excess water out. ***Step 4 – Squeezing.*** After squeezing to remove excess water, it is then stored as a ball (stored 2-3 days in a dark place). ***Step 5 – Sheet Making.*** The women spread and thoroughly press the fresh weed into a frame with a mesh made of bamboo. ***Step 6 – Drainage and Air Drying.*** The sheets are immediately removed from the frames and placed on racks made from spear grass ("phai nya") to drain water out. They are left over night to dry. ***Step 7 – Preparing the Herbal Dressing.*** This dressing is allowed to cool down over night. ***Step 8 – Applying the Dressing.*** The next day, the dressing is poured onto the sheets and spread evenly by softly hitting. ***Step 9 – Applying a Topping.*** The dressed sheets are sprinkled with sesame seeds, thinly sliced tomatoes and garlic. ***Step 10 – Sun Drying.*** The sheets are placed on grass mats and put in the sunshine for drying about 4-6 hours. ***Step 11 – Packaging.*** The dried sheets are removed from the grass sheets, folded and packed into plastic bags. Most women use only traditional manual methods with little use of machinery. Washing and cleaning are the most time-consuming operations and important for ensuring good quality.

MARKETING

The main buyers are: (1) the tourists visiting Luang Prabang and the local consumers who buy the dried sheets from markets and shops, and (2) the restaurants who then serve them to their customers. So far there is no substantial export market. The price depends on the river of origin and the physical characteristics (degree of green color, dryness, lack of fungi or wilting, etc.). Bags with labels are preferred by customers and sold out faster than bags without labels. Sometimes the marketing is based on trust by selling fixed quantities on a regular basis to big hotels, restaurants or well-known retailors. The price in Luang Prabang is lower than in tourist destinations of Thailand. More differentiated and attractive packaging could lead to a higher price, especially for tourists who may be interested in smaller quantities of guaranteed quality.

CONSTRAINTS

Main constraints include: (1) destruction of algae natural habitats and life cycles due to hydropower dam construction, which is permanent destruction, but also by gold mining or gravel removal from river beds, road building, etc. which can be temporary, (2) unsustainable harvesting methods, (3) intensification of agricultural practices with use of chemicals affecting aquatic ecosystems, (4) lack of technical solutions to improve washing and packaging, (5) lack of marketing strategy, support policy or research for development, (6) lack of awareness on the economic importance of agrobiodiversity.

POTENTIALS

The potentials to develop crispy river weed production, in the short term, include options for improving quality and price through technical support for the producers on management of algae production areas; improving the processing steps by the introduction of machines for washing, drying and packaging; labeling with quality assurance; and promotion under the "One Village One Product" brand. In the medium term, for a sustainable use of edible algae resources, there should be a comprehensive action plan to mitigate – if possible – the adverse impacts of hydropower development in each individual river.

SUMMARY

Crispy river weed production generates important household income, but the weed faces an uncertain future because of the destruction of its natural habitat due to human activities. This threat can only be reduced through concerted efforts in planning and implementing the national socio-economic development of the country while minimizing the negative impacts on agrobiodiversity. The "Khai pean" production is likely to decrease as hydropower development increases on the rivers where it grows.

WILD MUSHROOMS

PRODUCTION TYPES

A large number of wild mushrooms are available for consumption and sales throughout Lao PDR. Several are traditionally known for their unique food and medicinal properties, but some are also of unknown value and use. A few are also poisonous. There is still a lack of basic scientific information on many Lao mushroom species, their ecology, their potential uses as food or medicine, their potential toxicity and their geographical distribution.

Present knowledge on the Lao wild mushrooms is mainly based on local indigenous knowledge. Traditionally, Lao villagers often recognize three categories of mushrooms: (1) ***mushrooms growing on the ground*** (Het Din), (2) ***mushrooms growing on dead wood*** (Het Kgon) and (3) ***mushrooms growing on termite mounds*** (Het Phouak). These traditional categories partially correspond to three broad scientific categories:

The ***Mycorrhyza Mushrooms*** are those growing in symbiotic association with the roots of trees. Examples include the boletes (Boletus sp.), the milk-caps (Lactarius sp.), the amanitas (Amanita sp.) and the brittlegills (Russula sp.). Most edible forest mushrooms belong to this category and thus depend on the presence of trees.

The ***Parasitic and Saprophytic Mushrooms*** are usually growing on living or dead trees. One example is the "chicken of the wood" (Laetiporus sulphureus) fruiting in living trees. Other examples include the "split gill" (Schizophylla commune, known as Het Bee), Lentinus squarrolus (Het Dong), and several Ganoderma shishuanense (Het Lin), Auricularia polystricha (Het Hou Ling) and Neolentinus ponderosus (Het Pek). These mushrooms peak over a long period and can be seen year round. Some are more associated with decaying plant material and litter, such as Agaricus species and mushrooms closer to the cultivated straw mushrooms, for instance Volvariella volvacea (Het Fuang).

The ***Termite Mushrooms*** live in association with certain species of termites and grow on their mounds. This category contains some of the most commonly known mushrooms. About ten species of this type are likely to be present in Lao PDR (based on studies from Thailand).

PRODUCTION

Statistics on the Lao wild mushrooms are not available, but a large number of several species are collected and sold either for food or for medicinal purpose throughout the country. Indeed, a great number of mushrooms have important medicinal properties, including for curing cancer and other diseases. An example of non-edible mushroom medicinal mushroom is Het Lin Jeu/Ling Zheu (Ganoderma sp.). But most edible mushrooms have medicinal properties, such as the shitake (Lentinus erodes, known as Het Hom), the cloud ear (Auricularia polytrichia, known as Het Hou Ling), the cep (Boletus edulis, known as Het Pheun) and the wood blewit (Lepistas nuda).

Mushrooms are collected from the forest almost year-round, mainly by women, who sell them at markets or to small traders. The poorest landless villagers can collect mushrooms from communal forests.

A survey in Saythani district of Vientiane found 30 edible species from 18 genera in 11 families from a dry dipterocarp forest, with the most common family being Russulaceae. A survey by TABI in Chomphet district of

Luang Prabang (2013) listed 43 different mushroom types of which 12 were Russula sp. and 6 were Amanita sp. Another survey by the GEF/UNDP/FAO/MAF Agro-biodiversity Project (2013) in Phoukoud district of Xieng Khouang province listed 50 edible mushroom types and seven poisonous mushroom species. In both surveys, only a limited number could be assigned a scientific name with certainty.

CONSUMPTION AND SALES

According to a TABI survey, in 102 villages there were 6,575 HHs collecting 42 types of different mushrooms. Total income was estimated to be 3.7 billion kips, and average household income was 577 thousand kips/ HH per year. In a different survey, the agrobiodiversity product project recorded an average yearly income of 1.6 million kips among the active households.

PROCESSING

In general, edible mushrooms must be cooked for consumption. Mushrooms are usually fried, grilled or steamed. They can also be kept pickled in the water from steamed rice, with salt. Some species are dried in the sun and then kept for a long time. Some mushrooms are exported, either as dried or fresh. It is increasingly common for some selected mushroom species to undergo basic processing – such as drying – near the site of gathering before being exported.

MARKETING

Quality criteria include the following: young mushrooms are preferable as older specimens are tougher, have less taste and aroma, and are more difficult to clean. Mushrooms can be found in local markets throughout the country (along with cultivated mushrooms that are not covered in this fact sheet). Some species, like rid brittle caps (Het Daeng), are exported to China, while Het Wai/Het Phaek from the pine forests of Xieng Khouang province is exported to Japan.

CONSTRAINTS

In natural forests, access is open to all who want to collect mushrooms. No management system is normally followed. This may result in competition over collection and in over-exploitation. The loss of natural habitats, including deforestation, is a growing threat. Several mushrooms are associated with the dry dipterocarp forests, others with oak forests and some with pine forests. For instance, Het Daeng (Russula sp.) grows only under Fagaceae (oak) forest, and Het Pouak grows only near termite mounds. Het Bot and Het Khao grow mainly on host trees belonging to the Dipterocarpaceae family. Only conservation of these specific habitats and species can ensure future production of these mushrooms.

POTENTIALS

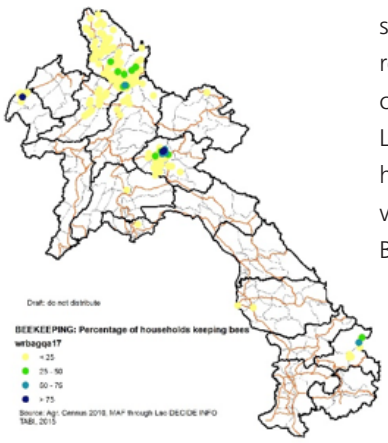
Large opportunities exist for wild mushrooms because the production is never considered sufficient. Improved forest management and cultivation of a diverse range of native mushrooms could earn substantial income. The experiences of TABI in helping some village communities in sustainable management of wild mushrooms could serve as examples to build on for further expansion. In addition, there are opportunities to join the Darwin Initiative project on Lao wild mushrooms to assist the local communities and authorities to establish sustainable harvest mechanisms.

SUMMARY

Wild mushrooms are essential parts of the agro-ecological systems with diverse functions including decomposition of living and dead materials, nutrient cycling, symbiotic relations with other organisms and stimulation of growth in a wide range of organisms. Several are used for food and for medicine, some also generate significant incomes for poor farmers who collect and sell them. However, due to deforestation, unsustainable exploitation and climate change, the Lao fungal diversity is changing and some species are increasingly under threat, whereas others may become more frequent, including some poisonous species. In general, there is a need for more scientific research on the wild mushrooms of Lao PDR (taxonomy, geographical distribution, marketing studies, etc.) in order to complement the present indigenous knowledge.

HONEY

Beekeeping distribution for 2011, (Map designed by Cornelia Hett).



PRODUCTION TYPES

Traditionally, Lao honey is a seasonal product collected from hanging hives of Apis dorata bees or from hollow log hives of Apis cerana. Because these traditional techniques of honey extraction are destructive, with limited productivity, they are progressively being replaced by the improved beekeeping techniques based on the use of top-bar hives, exploiting the Asian honeybee (Apis cerana). More and more village beekeeping groups are being formed. Lao honey is either consumed by villagers or sold in markets and shops. The quality of the Lao honey does not yet reach international standards (due to high moisture content), and the product is mainly consumed within Lao PDR. Through their interactions with flowers, honeybees enhance the production capacity of various crops and wild plants, especially fruit trees. Bees also provide bees wax, which has many uses.

In contrast to China, Vietnam and Thailand, from where huge quantities of honey are exported, the European honeybee (Apis mellifera) is generally not used in Lao PDR because it is less appropriate for the conditions of poor Lao villagers and is risky for the environment. Other honeybee species of Lao PDR include Apis florea, Trigona laeviceps, etc.

CURRENT PRODUCTION

Wild honey collection from the forest is mainly done in April-May, and honey comes either from the giant honeybee (Apis dorsata), a species producing only one large hanging comb and which is difficult to domesticate because it is not naturally confined in enclosed spaces, or from hollows in trees which are colonized by the smaller Apis cerana. Quantities are difficult to estimate, but they are certainly lower than those from beekeeping activities. Honey from beekeeping is growing in importance due to the improvement of techniques. Beekeeping is mainly practiced by upland villagers, especially by better-off households with time to tend to their hives.

Production statistics have been collected nationwide during the last agricultural census of 2011. Honey production supported by various projects has been documented for the provinces of Oudomxay, Phongsaly, Xieng Khouang, Luang Prabang and Huaphan. TABI is supporting beekeeping groups of 22 villages in three northern provinces for better bee raising, honey processing and marketing. Oudomxay has an association of beekeepers supported by foreign

NGOs. The Lao Farmers Products Company and a few other organizations also support honey value chains in some villages.

PRODUCTION, CONSUMPTION AND SALES

Honey production from beekeeping benefits rural households by generating additional income, food and medicine. Producing honey in apiaries with Apis cerana is a relatively low-input, low-output system compared to beekeeping systems with Apis mellifera in neighboring countries; this species requires more investment, but returns on labor may be similar. TABI's experience in Luang Prabang shows that 121 households were able to produce 2,059 kg of honey in one year, of which 1,871 kg were sold and generated 108,860,000 kips, equivalent to an average of 900,000 kips of income per household. In Xieng Khouang villages, the average income was 300,000 kips per household from selling honey. In addition these households had honey to eat (nutritious food).

PROCESSING

Honey processing activities usually take place on site, using traditional or more modern techniques. This makes honey an interesting Lao product in terms of domestically added value. However, Lao standards for honey processing are variable and often lower than those required for the international markets.

Processing activities could be summarized into two major broad steps: (1) honey extraction and (2) honey conditioning and packaging. The honey is extracted by putting pressure on the harvested honeycombs and draining to remove impurities, before it is stored in various types of containers.

MARKETING

While China and Thailand are the two major countries exporting honey in Asia, Lao PDR is only producing much lower honey quantities of different quality for domestic consumption. According to some preliminary information, the market demand is much higher than what is presently produced.

CONSTRAINTS

The main constraints for further development of beekeeping and honey production include (1) need for more widespread use of improved beekeeping techniques, (2) inadequate food and nectar sources, and (3) threats from the increasing use of pesticides in agriculture. It is worth keeping in mind that top-bar hives yield less honey but more wax (compared to more sophisticated hives).

POTENTIALS

The abundance of forest vegetation, fallow plants, crops and the increasing numbers of fruit orchards represent a great wealth of plants producing nectar and pollen in conditions that are suitable for installation of beehives. The abundance and diversity of vegetation formations and the juxtaposition of fruit growing in a wet tropical climate imply almost continuous flowering, limiting the periods of food, nectar and pollen, shortages for bees. Traditional beekeeping methods represent a good entry point for progressively introducing improved techniques that produce more honey for a longer period. The local Apis cerana, though less productive than Apis mellifera, is well adapted to the farming environment of Lao smallholders, more resistant to diseases, less risky and requires less care and less inputs. All these considerations give Lao PDR a strong apiarian potential with high value added locally and with the possibility of ultimately creating Protected Geographical Indications (PGI) for the Lao honey.

SUMMARY

There is a great potential for further developing beekeeping activities in Lao PDR, also because the honey produced from wild forest hives is unsustainable. To minimize risks, Lao PDR should favor the development of beekeeping based on the indigenous species Apis cerana (Asian honeybee) as opposed to Apis mellifera (European honeybee). The Quality standards of the honey should be improved by using better techniques for production, extraction and conditioning. Establishment of beekeeping groups should be supported. All this will help Lao farmers to diversify their activities, food sources and incomes, and strengthen their farming systems, while enhancing agrobiodiversity.

FISH FROM CONSERVATION ZONES

PRODUCTION TYPES

The Mekong River Basin supports the third most diverse fish fauna in the world and more fish species than any other river basin in Asia. More than 481 fish species (out of 924 species in the Lower Mekong Basin) have been identified in Lao PDR, including 22 introduced exotic species (of which some have become "invasive species"), and more species are being discovered. However, increasing pressure from human exploitation – such as overfishing with the use of explosives and electrofishing, fishing during the reproduction season, water pollution from agricultural pesticides and industry, and habitat disturbance, are all decreasing fish populations and threatening some species with extinction. These problems are particularly affecting small-scale fisheries that are very important in Lao PDR, where rural people heavily depend upon the Mekong's and its many tributaries' fish stocks for their livelihoods. This has led to the development of the concept and establishment of fish conservation zones (FCZs), or "no take" fish sanctuaries, throughout the country, including the northern upland region.

Fish conservation zones have traditionally been established in some regions as a village common asset with community-based management or even considered as sacred places. So far, scientific studies or research and development on fish conservation zones are still limited. Domestication of high-value indigenous fish is still very limited due to lack of investment in research and development and other external factors, and the FCZ concept is not fully developed due to several constraints.

CURRENT PRODUCTION

Total fish production from FCZs has not been estimated, while fish catch enhancement due to specific FCZs is also difficult to estimate. Many international organizations and projects have supported the development and establishment of river FCZs, called "Wang Sanguane" in Lao language. An official inventory of river FCZs has never been done, but some organizations, such as WWF, have established FCZs at more than 150 sites on the Mekong River and its major tributaries. TABI has supported FCZs in Luang Prabang (80 zones), Xieng Khouang and Huaphan. It is believed that many FCZs have been established

with similar concepts in every major tributary, but their actual operational status need to be reviewed and inventoried.

CONSUMPTION AND SALES

In Luang Prabang province, TABI support to 80 FCZs benefitted about 8,000 HHs (43,500 persons) in 72 villages of 8 districts. There were 618 HHs harvesting fish commercially in the areas of these FCZs (8% of the village population), and their total catch was estimated at 43,261 kg of fish (including a small amount of shrimps), of which 40% was consumed (17,050 kg) and 60 % was sold (26,211 kg). Total income for these 618 HHs was about 1 billion kips, corresponding to an average of 1.6 million kips/HH (equivalent to about 200 USD/HH). Average unit price for fish was 23,000 kips/kg, equivalent to 3 USD/kg. Preliminary information from Luang Prabang and Huaphan indicate that 10 to 20% increase of fishery capture can occur around FCZs.

PROCESSING

Organizing conservation zones can be complex and takes some time. The success of FCZs has normally been achieved by villagers themselves, who have adopted regulations including banning certain fishing methods, banning or limiting fishing in key deep-water areas (which are refuges or habitats for fish during the dry season), and managing natural wetland areas and juvenile fishes. Lessons learned indicate that the most productive FCZs are the ones located near or within a village – and some can even serve as a tourist attraction spot, like in the case of the TABI activity in Nam Et (Huaphan province) – because these are easier to protect and local people are proud of FCZ ownership.

MARKETING

There is high a demand for indigenous fish on the domestic market. The real problem is on the supply side. Fish are transported to markets packed in ice. Some indigenous fish costs two to three times more than fish from aquaculture, such as Tilapia, due to their special taste and relative scarcity.

CONSTRAINTS

The major constraints to the development of FCZs include (1) that invasive species such as Tilapia are a threat to indigenous species, (2) problems in implementation of co-management arrangements requiring an atmosphere of trust and mutual understanding between official staff, local authorities and villagers, (3) no single government agency is primarily responsible for wild-capture fisheries (i.e., nor MAF or MONRE), (4) there is a lack of documented information about living aquatic resources, (5) there is a lack of participation of people in the management of migratory fishes, (6) there are unresolved inter-village conflicts, or conflicts among user groups, and (6) construction of river dams block fish migration for many species, and dams higher than 5 m can almost totally destroy the fish population and thus fish catch.

POTENTIALS

Taking into account the very rich fish diversity of the Mekong and its 14 main tributaries in Lao PDR, there is in principle a great potential to develop and fully operate FCZs throughout the country. There are also numerous small rivers and streams that drain directly to the Mekong River that need to be investigated. The development of FCZs is not only good for biodiversity conservation, but also for maintaining or improving villagers' nutrition, scientific research, production of "One District One Product" branded products and tourism.

However, all these potentials are likely to be severely reduced by the widespread construction of hydropower dams. It is thus not clear if the remaining sections of rivers that will not be dammed will still possibly be viable FCZs.

SUMMARY

A sustainable management and development of river fish resources should be recognized by the government in its development plans, as it is a key component in improving food security for many rural people, as well as in providing them with additional income and occupation opportunities. River dams on Mekong tributaries will modify the aquatic resources in a drastic way, including fish populations in many fish conservation zones.

FISH IN RICE FIELDS

PRODUCTION TYPES

A well-known old Lao saying is "Having rice in the fields and fish in the water is an epitome of abundance and sufficiency." Fish and other aquatic products are an integral part of the life of rural people and are a main source of proteins and income generation. Rice-fish culture is traditionally practiced in several provinces, and a variety of systems are used, according to the local agro-climatic conditions of the area.

There are two types of fisheries in rice fields: (1) fish growing in wet rice fields without any intervention – occurs in very flat areas prone to flooding and (2) some level of management to enhance the fish stocks in the wet rice fields. There are different types of management. In some cases fingerlings could be raised by the farmers themselves in special purpose ponds during the dry season or, in other cases, fingerlings can be purchased. Fish culture in rice fields provides the means to produce grains and animal proteins on the same piece of land, and few other food production systems seem more ecologically sound and efficient.

CURRENT PRODUCTION

The Lao Agriculture Census 2010/11 (published in 2014) indicates that 68,200 farm households were engaged in aquaculture, and two-thirds of all Lao farm households were engaged in capture fisheries. From them, 78% (85% in Northern provinces) use the fish caught for their own consumption. Rivers are the main source of fish, followed by lakes, rice fields and swamps. The total aquaculture production was 54,750 tons, of which the rice-fish culture accounted for only 1,500 tons (average yield equals 250 kg/ha/year). In 2010/11, the total number of farm households engaged in rice-fish culture was 14%, with the highest percentage in Xieng Khouang (47% or 17,014 HHs) and Huaphan (24% or 10,152 HHs). Both women and men are involved in aquaculture, although each may have different roles at different stages of the fish production cycle. There are few cultural constraints to women's participation in most aquaculture activities.

CONSUMPTION AND SALES

The cost-benefit analysis of rice-fish culture operations with appropriate management in Xieng Khouang and Huaphan for 1 ha of unit area can be calculated as follows: (a) Labor inputs. Site preparation (cleaning, weeding) = 3 working days. Lime (to increase the water pH) and manure spreading = 2 working days. Feeding,

follow-up and maintenance = 10 working days. Harvesting = 5 working days. Sub-total for labor inputs: 20 man-days x 70,000 kips/unit = 1,400,000 kips. (b) Material inputs. Fingerlings: 4,500 fingerlings x 250 kips/unit = 1,125,000 kips. Lime: 50 kg x 5,000 kips/unit = 250,000 kips. Manure: 200 kg x 1,000 kips/unit = 200,000 kips. Feed rice bran: 50 kg x 2,000 kips/unit = 100,000 kips. Sub-total for material inputs = 1,675,000 kips. (c) Total costs for all inputs = 2,075,000 kips/ha. (d) Total income after 3 months: 250 kg/ha x 22,000 kips/unit = 5,500,000 kips/ha. (e) Benefit (gross margin) = 3,425,000 kips/ha. (f) Return on labor: 171,250 kips/man-day. NB: the yield could be increased up to 500 kg/ha by using bigger fingerlings (5-10 cm) with supplementary feed.

Another example from TABI in 6 villages of Xam Neua and Viengxay districts (Huaphan) involved 23 HHs who produced 1,636 kg, of which 379 kg were processed. Total income was 38.7 million kips for 23 HHs, meaning an average income of 1.7 million kips/HH (equivalent to about 206 USD/HH).

PROCESSING

Fish harvested from rice-fish culture is relatively small in size, due to the short period of growing. Most small fish are either eaten soon after harvest or used to make various types of fermented fish, such as Pa Dek, which is prepared by fermenting fish into a fish sauce. In Huaphan, the fish sauce Pa Bum, made from specific small fish, pa faad, raised in rice fields, is very famous and tasty and gets a price three times higher than normal fish. Sun dried and smoked fish are also very common processing practices. Post-harvest processing is predominantly a woman's activity in Lao PDR, and women would certainly form the majority of participants in these types of activities.

MARKETING

Marketing seems not be a problem because the domestic demand is very high and the supply is very limited, especially in the Northern provinces. Local merchants usually buy the fish directly from the farm. Another aspect is that fingerling and fry producers do generally not have problems in marketing their products due to high demands. This situation reveals that there is great potential to further develop rice-fish production. It should not be seen in terms of total tonnage produced or money received, but rather in terms of what pivotal role it can play in bridging the gap between subsistence agriculture and marketing of more of the household production and household food security.

CONSTRAINTS

Main constraints include the following (a) Input constraints. These include the shortage of fish fingerlings, the competition for manure to fertilize the rice fields, the competition for rice bran and agricultural by-products from other livestock activities, lime availability and cost in many areas, (b) Infrastructure and institutions. These involve limited livestock and fisheries extension services, provincial tendency to focus on peri-urban aquaculture, low productivity of government hatcheries (private hatcheries are rare). (c) Economic development. This relates to a less developed market economy outside of towns. (d) Environmental and social factors. Most fishponds are seasonal due to the six-month dry season, ponds are shallow and dry quickly, high temperatures are a problem for fishes as well as pollution from agricultural pesticides.

POTENTIALS

In Lao PDR, the potentials for capture fishery production from wet season rice fields and associated habitats is important, and it has been estimated that these areas occupy about 632,850 ha. Some studies noted the overall yield is likely to be low ranging, from 25 to 100 kg/ha/season. Lowland rain-fed rice fields can be improved just by applying farm manure and enhancing the fish stock, which would contribute immensely to fish production. In addition, rice-fish culture can increase rice yield about 15%. This is a win-win concept or approach that should be promoted. In some cases, this technique is also enhancing the biodiversity conservation by using indigenous fish, such as in Huaphan province, or by creating "One District One Product" brands with some specific rice species.

SUMMARY

Growing fish in ponds and stocking rice fields with fish has been a long tradition in Lao PDR, particularly in Huaphan, Xiengkhouang and other Northern provinces. It is very easy to stimulate interest in fish production among rural households nationwide. Since more than 70% of rural households undertake some fishing, their interest in increasing fish production is understandable.

MEDICINAL PLANTS

PRODUCTION TYPES

Most of the about 600 plant species used as traditional medicines in Lao PDR are wild plants, but some of them are increasingly being domesticated and cultivated. Some medicinal plants are used directly by villagers to treat various diseases, while others are collected and sold to markets or to pharmaceutical factories in or outside Lao PDR. Some are directly exported as raw material.

The utilization of traditional medicines in Lao PDR has been receiving political support since 1976 and, as a result, there is an Institute of Traditional Medicine (ITM, under Ministry of Health) in Vientiane with 10 provincial branches and also several public and private pharmaceutical factories manufacturing various drugs. Among the most well-known drugs is berberine (Kheua heam) from Coscinium fenestratum, prepared to treat wounds, dysentery and the after-effects of childbirth. At the national level, the ITM is the main source of information on medicinal plants used throughout Lao PDR. Some medicinal plants are becoming rare.

The Prime Minister's Decree No 155 of 2003 classifies medicinal plants in three categories: (1) rare and endangered species, (2) species that have high commercial value and can be used for domestic consumption and for exportation, and (3) species that are available in abundance throughout the country.

CURRENT PRODUCTION

Lao PDR is considered a mega-diverse country belonging to the Indo-Burma biodiversity hotspot with an estimated 8,000–11, 000 species of plants found in the country. An ethnobotanical survey conducted by the ITM, with support of the University of Illinois, in 2012 resulted in the identification of at least 573 species of medicinal plants in Lao PDR, while also collecting information from 118 traditional healers. Traditional knowledge of medicinal plants is considered more a function of geographic location rather than cultural diversity. There is a great diversity of diseases that are healed. The objective of that survey was to discover bioactive compounds that can be used in curing cancer, HIV/AIDS, tuberculosis and malaria; several were found, including new ones. Among others, new bioactive compounds against cancer and malaria were discovered in five plant species .

The majority of these resources are still collected from the wild, and this collection is supposed to be carried out in compliance with annual quotas set by the government. A small but increasing number of medicinal plants is also cultivated.

CONSUMPTION AND SALES

Collection and sales of products from traditional medicinal plants by villagers is a widespread practice in rural Lao PDR. For some of them, it can be a significant source of income. This could be illustrated with examples of activities supported by TABI. A survey by TABI in 118 villages found that 5,412 households were collecting 298 different types of NTFP for medical purposes, resulting in an average income of 725,484 kips/HH per year. It was also found that more than 65% of the collections were taking place in various types of village forests and in bush fallows.

PROCESSING

Processing methods and steps required for making medicines depend on the plant species and the parts involved. As a result of a policy to support the use of medicinal plants in Lao PDR, several pharmaceutical processing units use Lao medicinal plants to make drugs. Processing of medicinal plants can take place at farm level, in public or private factories within Lao PDR or abroad, depending on the product.

MARKETING

Various parts or extracts from medicinal plants are generally sold by market vendors throughout the country. A smaller number of plant products are also sold to buyers for exploitation in pharmaceutical factories. Finally, there are some plant products that are sold and exported for making drugs in foreign countries.

CONSTRAINTS

Over-exploitation, loss of natural habitats and growing pressures on natural resources are among the main problems faced by several medicinal plants. The use of traditional medicinal plants continues to be an important part of the culture of Lao communities.

Since 1986, the market economy's effect on the use of medicinal plants has increased year by year, with medicinal plants harvested not only for domestic consumption, but also for the international market. Insufficient planning and inappropriate use of this valuable resource could lead to severe reduction in the country's biodiversity. For example, Coscinium sp. and the rare orchid species Anoectochilus sp. are under severe threat and extirpated in some areas. There is a need to strengthen current laws and regulations, and their implementation, to ensure the protection of such a vital resources and the natural environment that supports them. Main problems include (1) no systematic and scientific approaches to harvesting, (2) no specific plans for cultivation, (3) no strict enforcement of laws and regulations, (4) weak collaboration among concerned authorities, between central and local authorities, and between public and private sectors, and (5) limited awareness among rural people on the preservation of biodiversity.

POTENTIALS

Main potentials can be summarized as follows: (1) there are government policies in place to support the sustainable use of medicinal plants, (2) there is an Institute of Traditional Medicine that has accumulated knowledge and experiences on medicinal plants, (3) the government promotes the cultivation of medicinal plants for export, (4) cultivation of some medicinal plants has been initiated at community level, and (5) several foreign companies have also been investing in the cultivation of some medicinal plants (Styrax tonkinensis, Orthosiphon stamineus, Dendrobium sp., Aquilaria sp., Amomum sp.).

SUMMARY

Lao PDR has a huge number of traditional medicinal plants, including some of international interest, which can be used against diseases such as cancer, HIV/AIDS, tuberculosis and malaria, but several are under threat from unsustainable exploitation and loss of natural habitats. More scientific and community-oriented management of medicinal plant resources should be supported. Production and export statistics should be improved. Illegal exploitation and trade of endangered species should be reduced by better border controls and law enforcement. Traditional knowledge on medicinal plants should be protected as intellectual property rights of Lao traditional healers. Sustainable cultivation for export should be encouraged.

WILD SUGAR PALM (MAK TAO)

PRODUCTION TYPES

Wild sugar palm fruit (Mak Tao) is the Arenga westerhoutii tree, a palm native to Southeast Asia that proliferates freely in humid forests and typically grows near streams, rivers or other water sources. The fruit is consumed as a dessert in Lao PDR and Thailand. The tree provides several other products: palm wine from the apex of the flowers and roofing material from the leaves. Shoots are also edible, but their collection kills the plant, but the most significant products are the seeds.

The tree grows to about 10 meters high and produces seeded fruits after 13 years, after which it bears fruits again every two years. After three or four harvests, the tree dies. Harvesting usually takes place between November and January. In Lao PDR, Mak Tao is collected from wild trees.

There is no regeneration program, though a 1999 Ministry of Agriculture and Forestry (MAF) instruction to the Provincial Agriculture and Forestry Offices (PAFOs) states that for every 1 ton of palm fruit collected, 10 trees should be planted, and otherwise a fine should be paid. Cultivation may be possible, but the tree requires many years to bear fruits. However, without cultivation or forest management, the sustainability of Mak Tao is unlikely.

CURRENT PRODUCTION

Exact production is unclear, but it is estimated that about 1,000 tons of unprocessed seeds are exported to Thailand. Some Mak Tao is being collected in northern Sayaboury (mainly Xienghone district), Oudomxay, Xieng Khouang, Bolikamxay and Khammouane provinces. A tree has on average four clusters of fruit at a time and can yield 200-300 kg of fruit. Every 10 kg of fruit provides 3-3.5 kg of seed. A family can collect up to 70-100 kg per day. As with other NTFPs, producers cite a general decline in natural productivity as tropical forest land is cleared for logging and growing crops. In addition, young palm shoots are being consumed. It was reported

that in northern Sayaboury, 1,650 HHs were producing palm fruit in Xienghone district, 100 HHs in Ngeun district, 5 HHs in Hongsa district and 3 HHs in Saysatthan district. In 2011, Sayaboury exported about 1,023 tons of Mak Tao valued at 215,548 USD, representing 23% of province NTFP exports by value. Villagers reported a selling price of 3,500 kips/kg in Sayaboury. Reported export volumes have remained relatively stable over the years, while unit prices have declined. Oudomxay exported about 2,453 tons of Mak Tao in 2009.

The annual quota structure for NTFP traders, regulated by PAFO and MAF, is market based to limit product collection to levels in line with theoretical market demand. However, the quota applies to what the trader can purchase, not what the villager can collect and stockpile. Therefore, the quotas are not limiting collection to levels that assure sustainability of the product or that can restrict supply to encourage higher prices for producers.

CONSUMPTION AND SALES

Given that there is little input cost other than family labor, a household has the potential to achieve high rates of return on the collection, pre-processing and sale of the palm fruit. For example in a village of Xienghone district, a family selling 95 kg of palm fruit during the 2011 season at 4,200 kips/kg generated a total household income of 400,000 Kips (equivalent to about 48 USD/HH).

A study conducted in 2014 in Khammouane province (Hin Nam No) concluded that the following scenario may happen: Considering 3 workers per household collecting Mak Tao during 3 months (January-March) they can collect 10 kg of Mak Tao/person/day. Assuming 23 days of work per month, the total production per household would be 2,070 kg, which could be sold for 3,000 kips/kg, generating an average income of 6.2 million kips/HH in 3 months (equivalent to about 750 USD/HH).

PROCESSING

Before the palm fruit is sold by villagers to traders, the following steps are involved: (1) collection from the forest, (2) splitting the fruit, (3) extracting the seed, (4) boil and soak the seeds. The pre-processed seeds are then purchased by village collectors or traders and then fully processed in Lao PDR or in Thailand or Vietnam.

Almost all palm fruit collected in Sayaboury province is exported to Thailand for processing by canning factories. Lao PDR is the main supplier of palm fruit to Thailand since natural stands of Arenga westerhoutii have become rare in Thailand. Fruits from Sayaboury that are not exported to Thailand are traded domestically in Luang Prabang and Oudomxay. There is also a processing factory near Vientiane.

MARKETING

In theory, the product could command a premium due to its "organic" nature, but this has not yet been reflected in the market price. Like most NTFPs, palm fruit is sold to traders, which are few in numbers. The ability to negotiate is hampered by lack of competition and spot-market transactions. Palm fruit quality is broadly categorized by color and pre-processing moisture levels, with three grades: (a) White dry fruit, (b) white fruit soaked in water, and (c) blackish fruit, which can be bleached by the processor.

CONTRAINTS

The main constraints include the following: (1) market risk due to concentration in single market, (2) natural supply is under threat due to loss of habitat and slow maturation rate (13 years for a tree to bear fruits), (3) prices realized by producers may be low due to lack of trader competition and the spot-market nature of transactions, (4) limited access to markets and support services, (5) without proper handling, product spoilage may occur within a few weeks of harvest, limiting the ability of producers to stock the Mak Tao when demand is low, (5) informal market and geographic distance cause difficulty in mapping tree stands, understanding capacity and tracking sales volumes.

POTENTIALS

The main opportunities for palm fruit production could be summarized as follows: (1) strong demand for export to Thailand as well as domestic market, (2) potential to add value through processing in Lao PDR, and (3) extended storage with limited spoilage is possible under appropriate conditions. Sustainable production can be achieved by maintaining wild populations with plenty of younger trees that constantly replace the older trees.

SUMMARY

The palm fruit Mak Tao is collected from scattered natural stands in humid forests from different parts of the country, where it is locally important for income generation. The demand is high, but the supply is declining due to loss of habitats and over-harvesting. Thailand is a major importer. Production can virtually not be expanded through domestication/cultivation in other regions because it takes 13-16 years for a tree to bear fruits. Present efforts should concentrate on sustainable harvesting of the existing stands by local communities, combined with appropriate regulations on trade quotas. More fruit processing within Lao PDR should also be encouraged.

CONSULTED REFERENCES

The fact sheets were prepared by collecting information from publications, reports, working documents, web-sites and from discussions with various resource persons. Project data, cases from the relevant TABI sub-projects (SPAs) and from the CDE of Bern/Lao DECIDE Info (for a few products) were also exploited. Some project data, for bamboo, came from GRET, and some from WWF (for rattan). Two documents deserve to be mentioned here because they were used more often than the others, and this for several agrobiodiversity product fact sheets:

(1) TABI, 2014. ***The Agro-Biodiversity Initiative (TABI-Phase 2) "promoting Lao agrobiodiversity as driver for uplands development". Year 2 Progress Report: covering 1 July 2013 – 30 June 2014.*** SDC-NIRAS-TABI – MAF, Vientiane. 102 pages.

(2) NAFRI, NUoL, SNV, 2007. ***Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products.*** The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

All the consulted references are listed below and are regrouped product by product for easy reference in case a reader is willing to know more about a particular product.

LITTLE CHICKEN RICE (KHAO KHAI NOI)

Schiller J.M., Chanphengxay M.B., Linquist B., and Appa Rao S., 2006. Rice in Laos. Los Banos (Philippines): International Rice Research Institute (IRRI). 457 pages.

TABI, 2014. File on SPA 024: KKN Seed Improvement and Quality Multiplication (Xam Neua district, Huaphan province).

TABI, 2014. File on SPA 029: KKN Seed Improvement and Production Promotion (Xieng Khouang province).

TABI, 2014. File on SPA 049: KKN Breeding and organic production (Phoukoud district, Xieng Khouang province).

Other sources also consulted: several articles published in the Vientiane Times during 2014 and 2015 on Khao Khai Noi were also consulted, as well as PowerPoint slides on rice biodiversity by Dr. Chay Bounphanouxay from NAFRI/ARC.

BAMBOO

Boupha L., Foppes J., Wanneng P., Sayasouk B., Souphangthong B., Thongkham and O. Sichaleune, 2006. Case Study on Bamboo Marketing in Lao PDR. ICRAF-SEANAFE Project "Market and Agroforestry Tree Products". NUoL/ICRAF. 55 pages.

Daunenmann B.M.E., Choocharoen C., Spreer W., Nagle M., Leis H., Neef A. and J. Mueller, 2007. The Potential of Bamboo as a Source of Renewable Energy in Northern Laos. Tropendag 2007. Conference on International Agricultural Research for Development, October 9-11, 2007. University of Kassel-Witzenhanzen and University of Göttingen. 5 pages.

Dransfield S., Widjaja E.A. (editors), 1995. Bamboos. Plant Resources of South-East Asia No 7. PROSEA, Bogor, Indonesia. 192 pages. (Not available in PDF)

EMD-LDN, 2010. Bamboo Value Chain in Luang Prabang. SNV. 30 pages. (Not available in PDF)

Greijmans M., Hitzges C., 2012. SNV Bamboo Programme: Approaches, Lessons and Innovations in Lao PDR. SNV. 61 pages.

Greijmans M., Soukchaleunphone S., Phommasane S., 2009. Lessons from Lao PDR: thoughts on scaling up pro-poor bamboo value chain interventions. SNV. 5 pages. (Not available in PDF)GRET-SNV, 2014. Bamboo Project. Towards co-management of a sustainable bamboo sector in Huaphan Province through villagers'empowerment. (Factsheet) 2 pages.

INBAR, undated. Bamboo – A Brief Introduction. A unique resource for a green economy. (Factsheet) 2 pages.

INBAR, 2009. Capturing Carbon with Bamboo. Fast and Effective in Managed Stands. INBAR Environment Factsheet No. 3, COP 15, Copenhagen, December 7-18, 2009. 2 pages.

INBAR, 2014. Bamboo: A Strategic Resource for Countries to reduce the Effects of Climate Change. Policy Synthesis Report 1. International Network for Bamboo and Rattan (INBAR), Beijing. 28 pages.

Junqi W. (compiler & editor), 2014. International Trade of Bamboo and Rattan 2012. International Network for Bamboo and Rattan (INBAR), Beijing. 62 pages.

MAF, 1997. A Manual of the Bamboos of the Lao PDR. Bamboo and Rattan Research Project, Field Document No 1, DOF/IDRC. Ministry of Agriculture and Forestry, Department of Forestry. October 1997. 108 pages. (Not available in PDF)

Muthoo M.K., 2012. Forest Certification and the Green Economy. Unasylva 239, Vol. 63, 2012/1. 7 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Nath A.J., and A.K. Das, 2012. Carbon pool and sequestration potential of village bamboos in the agroforestry systems of northeast India. Tropical Ecology 53 (3): 287-293, 2012. 7 pages.

Song X., Zhou G., Jiang H., Yu S., Fu J., Li W., Wang W., Ma Z., and C. Peng, 2011. Carbon sequestration by Chinese bamboo forests and their ecological benefits: assessment of potential, problems, and futures challenges. Environment Rev. Vol. 19: 418-428, 2011. 11 pages.

TABI, 2014. File on SPA 2: Sustainable Bamboo Shoot Processing and Bamboo Forest Management (Phoukoud district, Xieng Khouang province).

Viravongsa D., Greijmans M., 2009. Xiengkhouang Province Market Scan – Bamboo Sub-sector. Identifying SNV's Potential Advisory Services for Development of the Bamboo Sub-sector. SNV. 10 pages. (Not available in PDF)

Yiping L., Henley G., 2010. Biodiversity in Bamboo Forests: a Policy Perspective for Long Term Sustainability. International Network for Bamboo and Rattan (INBAR), Beijing. 17 pages.

Yiping L., Yanxia L., Buckingham K., Henley G. and Z. Guomo, 2010. Bamboo and Climate Change Mitigation: a comparative analysis of carbon sequestration. Technical Report No 32, International Network for Bamboo and Rattan (INBAR). 30 pages.

NATIVE CHICKENS AND PIGS

Bouahom B., Keonouchanh S. and Khamphavong S., 2007. Indigenous Chickens: An Important Part of Rural Livelihoods in the Lao People's Democratic Republic. 8 pages. Pages 71-77 in Tempelman K.A. and Cardellino R.A. (editors), 2007. People and Animals Traditional Livestock Keepers: Guardians of Domestic Animal Diversity. FAO. 134 pages. (Note: this short article contains illustrated descriptions of the five main local chicken breeds of Laos)

Keonouchanh S., Egerszegi I. and Ratky J., 2009. Native Pigs (Moo Lat) Production in Lao PDR. 7 pages. (Note: contains descriptions of the main local pig breeds of Laos)

Keonouchanh S., Egerszegi I., Ratky J., Bouahom B., Manabe N., Brussöw K.P., 2011. Native Pig (Moo Lat) Breeds in Lao PDR. Archiv Tierzucht 54 (2011) 6, 600-606. Leibniz Institute for Farm Animal Biology, Dummerstorf, Germany. 7 pages. (Note: this article contains illustrated descriptions of the 4 main local pig types found in Laos)

Phengsavanh P., Ogle B., Stür W., Frankow-Lindberg B.E., Lindberg J.E., 2011. Smallholder Pig Rearing in Northern Lao PDR. Asian-Australian Journal of Animal Science, Vol 24, No 6, 867-874 June 2011. 8 pages.

TABI, 2014. File of SPA 8, Improved Techniques for Native Pigs (Ponxai district, Luang Prabang province).

TABI, 2014. File of SPA 15, Native Chicken Improvement and ABD use (Phoukoud district, Xieng Khouang province).

TABI, 2014. File of SPA 58, Native Chicken Raising with ABD Management (Sobhao district, Huaphan province).
TABI, 2014. File of SPA 62, Strengthening Native Pig Raising (Chomphet district, Luang Prabang province).

COFFEE IN NORTHERN UPLANDS

Cai C.T., Cai Z.Q., Yao T.Q. and Qi X., 2007. Vegetative Growth and Photosynthesis in Coffee Plants under different Watering and Fertilization Managements in Yunnan, SW China. Photosynthetica 45 (3): 455-461, 2007. 7 pages.

CNCL, 2012. Lao Coffee Sector Development Strategy. Prepared by AFD funded PRCC-II project – Support for the Commercial Development of the Lao Coffee Supply Chain with the contribution of GIZ and the public and private stakeholders of the Lao coffee sector. The Secretary's Office of the Lao National Coffee Council, Lao PDR. 87 pages.

Edwark W., Op de Laak J., Marsh T., Herbert L. and K. Chapman, 2005. Arabica Coffee Manual for Lao PDR. FAO RAPA, Bangkok. 72 pages.

Galindo J., Sallée B., 2007. Participative Analysis of Coffee Supply Chain in Lao PDR. Groupe de Travail Café (GTC). November 2007. 85 pages.

ITC, 2010. The Coffee Sector in China – An Overview of Production, Trade and Consumption. Technical Paper. International Trade Centre, Geneva. 31 pages.

SADU, 2011. The Revival of Coffee Growing in Kaew Set, Xieng Khouang province. Case Study. Accelerating Poverty Reduction through Linking Farmers to Market. Lessons from the Small-holder Agricultural Market Development in the Uplands of the Lao PDR project. SDC/CIAT/NAFRI/NAFES. 8 pages.

TABI, 2014. File on SPA 065: Coffee Plantation in Khoun District (Xieng Khouang province).

TABI, 2014. File on SPA 066: Coffee Plantation for Market in Phaxay District (Xieng Khouang province).

Various Chinese websites consulted: www.chinadaily.com ("Planting coffee in Laos", 2014-07-22), www.yncoffea.com, www.laoscoffea.com (for information on the coffee plantations in Phongsaly province by the Yunnan Changshengda Investment Company), www.scmp.com ("Yunnan, Chinese province famous for tea, now looks to coffee", November 3, 2013). Other websites: www.ft.com ("Chinese farmers gain taste for Coffee", November 2, 2014), www.forbes.com ("Coffee in Yunnan, China (I): Nestle's new model" May 14, 2014), www.newsecuritybeat.org ("Can Coffee Make Yunnan a Model for Chinese Agricultural Reform?" April 10, 2013), www.wilsoncenter.org ("CES 12 Preview: Sustainable Coffee Growing in Yunnan" February 19, 2013), www.economist.com ("Yunnan's caffeine rush for all the coffee in China", January 28th, 2012).

WILD TEA IN NORTHERN UPLANDS

Ahmed S., Stepp J.R., Toleno R.A.J. and C.M. Peters, 2010. Increased Market Integration, Value, and Ecological Knowledge of Tea Agroforests in the Akha Highlands of Southwest China. Ecology and Society Vol. 15 (4): 27. 18 pages.

Boupha T., 2013. Lao Tea Sector. (PowerPoint slides, 18-09-2013). 25 pages.

CARE, 2009. Background Paper: Wild Pu-erh Tea – A High-value Niche Product for the Lao PDR. Lao Wild Tea Sector Development – Stakeholder Workshop, Vientiane, August 18th 2009. Supported by SDC. 9 pages.

CARE, 2009. Lao Wild Tea – An Overview. (Powerpoint Slides) 13 pages.

CARE, 2009. Lao Wild Tea Sector Development. Stakeholder Workshop Report. Vientiane, August 18th 2009, Lane Xang Hotel. Supported by SDC. 10 pages.

CARE, 2009. Tea Development Process. Kokang Special Region No 1, Northern Shan State, Myanmar. (PowerPoint slides). 9 pages.

CARE, 2009. One Private Sector Perspective. (PowerPoint slides). 6 pages.

Folkard A. and Pathammavong O., 2008. PARUA Phase II. Tea Production and Market Development. Progress Report. Farmer-to-Farmer mechanisms & Market Development Strategies. SDC/CARE. 28 pages.

GEF/UNDP/FAO-MAF Agrobiodiversity (APB) project, 2014. Conservation and Management of Wild Tea in Gnodphae Village. Project document. DAFO & Phoukoud District, Xieng Khouang province. 19 pages.

NAFRI, 2009. Developing Tea in Muang Moeng, Bokeo Province. URDP Field Report # 0901, August 2009. By Northern Agriculture and Forestry Research Centre. 10 pages.

NAFRI, 2010. Northern Lao Forest Teas Cupping Report. Vientiane, 10th May 2010. 7 pages.

NAFRI, 2011. Background Paper: Tea Sector – Challenges and Opportunities. Lao Forest Tea project (supported by SDC), prepared for the Concluding Workshop, Vientiane April 29th 2011. 12 pages.

NAFRI-NAFReC, 2011. Development of Wild Tea Sector in Bokeo. Northern Agriculture and Forestry Research Center. (PowerPoint slides). 7 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.Smith D., Boupha T., Phouyyavong K., Inthavong T., Boupha T., Ketphanh S. and Y. Mei, 2011. Yunnan Market Study Report. A report prepared for NAFRI, URDP, CIAT and

CARE International. Lao Forest Tea project (supported by SDC). 40 pages.

TABI, 2014. File of SPA 21 on NTFPS including tea gardens in Nam Bak district, Luang Prabang province.

Wu Y., Chanhda H., Zhang X., Yoshida A. and C. Wu, 2011. Tea Industry Development and Land Utilization along the China-Lao border: A case study of Komen Village in Laos. African Journal of Business Management Vol.5 (11), pp. 4328-4336, June , 2011. 9 pages.

BENZOIN

Agroforex Company Vientiane: data on benzoin in Huaphan and Phongsaly.

FAO/WHO, 2014. Joint FAO/WHO Expert Committee on Food Additives. Compendium of Food Additive Specifications. 79th meeting 2014. FAO JECFA Monograph 16. ISSN 1817-7077. FAO and WHO, Rome. 93 pages. (Note: this document contains information related to the possible approval of Lao benzoin as a flavoring agent for inclusion in the Codex Alimentarius).

FAO/WHO, 2014. Joint FAO/WHO Expert Committee on Food Additives. Seventy-ninth meeting. Geneva, 17-26 June 2014. Summary and Conclusions. Issued 2 July 2014. JECFA/79/SC, FAO. 18 pages. (Note: this document contains information related to the possible approval of Lao benzoin as a flavouring agent for inclusion in the Codex Alimentarius).

Fisher M., Savathvong S. and Pinyopusarerk K., 2007. Upland Fallow Management with Styrax tonkinensis for Benzoin Production in Northern Lao PDR. Pp. 564-570 in Cairns M. (Editor), 2007. Voices from the Forest. Integrating Indigenous Knowledge into Sustainable Upland Farming. Resources for the Future, Washington DC, USA. (Not available in PDF)

Kashio M., Johnson D.V., 2001. Monograph on Benzoin (Balsamic resin from Styrax species). RAP Publication: 2001/21. FAO, Bangkok, Thailand. 211 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Pinyopusarerk K., 1994. Styrax tonkinensis: Taxonomy, ecology, silviculture and uses. ACIAR Technical Reports No 31, Canberra. 20 pages.

Rath S. 2012. Benzoe tonkinensis: Chemical and Technical Assessment. 8 pages. (Note: this document contains information related to the possible approval of Lao benzoin as a flavoring agent for inclusion in the Codex Alimentarius).

TABI, 2014. File on SPA 055: Benzoin Forest Conservation in Phonthong (Luang Prabang province).

Vora-Ouankham B., Xayxomphou B., 2013. Report on Market Value Chain on Benzoin in Khoua District, Phongsaly Province. Northern Uplands Development Programme (NUDP). 26 pages.

Weyerhaeuser H., Bertomeu M., Wilkes A., Mei Y., 2010. Cross-border NTFP Value Chains Laos-China. 22 pages. (Note: In spite of its general title this report actually covers two products: Lac exudate "Sticklack" and Benzoin resin)

Websites of the companies Biolandes (France) and Givaudan (Switzerland) that extract and use essential oils from the Lao benzoin: www.biolandes.com and www.givaudan.com

Website of the FAO/WHO joint commission on Codex Alimentarius www.codexalimentarius.org

CARDAMOM

Aubertin C., 2004. Cardamom (Amomum spp.) in Lao PDR: the hazardous future of an agroforestry system product. Pages 43-60 in Kusters K. (ed.), Belcher B. (ed.) Forest products, livelihoods and conservation : case studies of non-timber forest product systems : 1. Asia

CCL, 2015. La Culture de la Cardamome à Gnot-Ou. 4 pages.

Choocharoen C., Schneider A., Neef A. and P. Georgiadis, 2012. Income Options for the Poorest of the Poor: The Case of Cardamom in Northern Laos. Small-scale Forestry 01/2013; 12 (2). 21 pages.

Ducourtieux O., Visonnavong P. and J. Rossard, 2006. Introducing Cash Crops in Shifting Cultivation Regions – The Experience with Cardamom in Laos. Agroforestry Systems (2006) 66: 65-76. 12 pages.

Ducourtieux O., Visonnavong P., Rossard J., 2004. Cultures commerciales de montagne: L'expérience de la cardamome. PPDP, AFD/CCL. 20 pages.

Feng Y.L. and Li X., 2007. The Combined Effects of Soil Moisture and Irradience on Growth, Biomass allocation, Morphology and Photosynthesis in Amomum villosum. Agroforestry Systems (2007) 71: 89-98. 10 pages.

Gao L. and Liu H.M., 2009. Rotation System for Cardamom planting and Forest Regeneration in the Tropical Rainforest of Southwest China. Journal of Tropical Forest Science 21(3): 190-197 (2009). 8 pages.

Khamphiyom S., Xayxomphou B., 2013. Report on Market Value Chain on Cardamom in Khoua District, Phongsaly province. Northern Uplands Development Programme (NUDP). 32 pages.

Kvitvik T., 2001. Cultivating and collecting Cardamom (Amomum spp.) and other NTFPs in Muang Long District, Luang Namtha Province, Lao PDR. 32 pages.

Liu H., Gao L., Zheng Z. and Z. Feng, 2006. The Impact of Amomum villosum Cultivation on seasonal Rainforest in Xishuangbanna, Southwest China. Biodiversity and Conservation (2006) 15:2971-2985. 15 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

TABI, 2014. File on SPA 060: Management and regeneration of Cardamom and Nor Loydin bamboo shoots (Houamuang district, Huaphan province).

Tuan L.A., 2011. Case Study 8: Tapping the Potential of Cardamom for Poverty Reduction and Sustainable Forest Protection. Pages 42-50 in Case Studies 2010, SNV Netherlands. 9 pages.

Zhou S., 1993. Cultivation of Amomum villosum in tropical forests. Forest Ecology and Management, 60 (1993) 157-162. 6 pages.

RATTAN

Campbell R., 2009. The Economic Potential of Rattan Shoot Production as a Food Crop in Lao PDR. Technical Report, Sustainable Rattan Harvest and Production, WWF Greater Mekong, Lao PDR Country Programme. 22 pages.

Campbell R. and Knowles R., 2011. Project Evaluation of WWF Sustainable Rattan Project in Lao PDR. Final Report. Prepared for the WWF Greater Mekong Lao Country Programme, October 2011. 27 pages.

Darwin Initiative, 2001. Diversity and Sustainable Management of Rattans in Lao PDR. Final Report. Darwin Initiative for the Survival of Species, A Research and Training Project (October 1997-March 2001). 34 pages.

Dransfield J., Tesoro F.O. and N. Manokaran, 2002. Rattan – Current Research Issues and Prospects for Conservation and Sustainable Development. Non-Wood Forest Products 14, FAO, Rome. 269 pages.

Evans T., 2002. The Status of the Rattan Sectors in Lao People's Democratic Republic, Viet Nam and Cambodia – with emphasis on cane supply. Pages 115-144. In Rattan – Current Research Issues and Prospects for Conservation and Sustainable Development. Non-Wood Forest Products 14, FAO, Rome. 29 pages.

Evans T., Sengdala K., Thammavong B. and Viengkham O.V., 2001. A Field Guide to the Rattans of Lao PDR. Royal Botanic Gardens, Kew, UK. (Not available in PDF)

Evans T., Sengdala K., Viengkham O., Thammavong B. and Dransfield J., 2000. Four New Species of Calamus (Arecaceae: Calamoideae) from Laos and Thailand. Kew Bulletin 55:929–940 (2000). 4 pages. Henderson A. and Henderson F., 2007. New Species of Calamus (Palmae) from Lao and Myanmar. Taiwania, 52(2): 152-158, 2007. 7 pages.

Hirschberger P. (edited by Emma Duncan), 2011. Global Rattan Trade: Pressure and Forest Resources – Analysis and Challenges. Establishing a Sustainable Production System of Rattan Products in Cambodia, Laos and Vietnam, WWF Austria. 84 pages.

Hirschberger P., 2011. Global Rattan Trade: Pressure on Forest Resources – Analysis and Challenges. Summary. WWF Austria, February 2011. 2 pages.

Hourt K.E., 2008. A Field Guide of the Rattans of Cambodia. WWF Greater Mekong, Cambodia Country Programme. 74 pages.

Junqi W. (compiler & editor), 2014. International Trade of Bamboo and Rattan 2012. International Network for Bamboo and Rattan (INBAR), Beijing. 62 pages.

Knowles T. and Campbell R., 2011. Financial Modelling and Analysis of FSC certified Rattan in Lao PDR. Report prepared for the WWF Greater Mekong Programme, November 2011. WWF. 32 pages.

Koulang C., Viet Tam L. and Ledecq T., 2013. Rattan

Industry in Cambodia – Opportunity and Challenge of Human Resources for moving towards Green Economy. Vision 2030, EuroCHAM Cambodia, Power Point presentation (December 6th 2013, Phnom Penh). 15 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Perlis A. (editor). Rattan. Unasylva – Vol. 52-2001/2, FAO. 99 pages.

Peters M.C., Thammavong B., Mekaloun B., Phearoom N., Ratanak O. and Ledecq T., 2013. Growth of Wild Rattans in Cambodia and Laos: Implications for Management. Forest Ecology and Management 306 (2013): 23-30. 8 pages.

Phachomphonh B., 2014. Taxation of FSC Rattan Eastern Basket Production in 2014. By Sustainable Rattan and Bamboo Harvesting and Production in Lao PDR, WWF. (PowerPoint presentation). 22 pages.

Roscher B., Lindsten C., Brolund P., Broberg T., Ledecq T. and Gephart N., 2011. Sustainable Rattan Design – The Mekong Region. European Union/WWF. 44 pages.

Sayarath S., 2014. Review of Coop 15 Easter Basket production by community and Danlao Co. Ltd. Sustainable Rattan and Bamboo Production and Harvesting, WWF. (PowerPoint presentation). 28 pages.

Shim P.S., 1995. Domestication and Improvement of Rattan. INBAR & IDRC Working Paper No 5, International Network for Bamboo and Rattan (INBAR), Beijing. 33 pages.

Singh H.B., Puni L., Jain A., Singh R.S. and Rao P.G., 2004. Status, Utility, Threats and Conservation Options for Rattan Resources in Manipur. Current Science, Vol. 87, No 1, 10 July 2004. Pp. 90-94. 5 pages.

TABI, 2014. File on SPA 012: Promotion of NTFPs and Agroforestry (Phoukoud district, Xieng Khouang province).

TABI Update Issue No 4, February 2014. TABI supports sustainable Rattan harvesting by providing funding to the WWF led "Sustainable Rattan Production and Harvesting Project". Pages 4-5. Van Dong L., 2014. Sustainable Rattan & Bamboo Project WWF Vietnam. NTFP Value Chain Workshop, Oct. 17, 2014. (Power Point Presentation). 26 pages.

Williams J.T., Noor N.S.M. and Rao I.V.R. (editors), 1999. Inventory Techniques and Assessment of Rattan and Bamboo in Tropical Forests. Technical Report No 11. International Network for Bamboo and Rattan (INBAR). 98 pages.

Wheatley C. and Peters D., 2008. Rattan in Savannakhet and Khammouane Provinces, Lao PDR. Part of 3 value chain analysis and programme development study. SNV (Netherlands Development Organization). 8 pages. WWF, 2011. A Switch to Sustainable Rattan Production and Supply. (Factsheet). 2 pages.

WWF, 2011. Establishing a Sustainable Production System for Rattan Products in Cambodia, Laos and Vietnam. Duration: 01.01.2009 – 31.12.2011. (Power Point Presentation). WWF Austria. 12 pages.

WWF, 2011. Establishing a Sustainable Production System for Rattan Products in Cambodia, Laos and Vietnam. Switch Asia programme (Poster). 1 page.

WWF, 2011. How Community-base of Rattan Contributes to Conservation. (Poster). 1 page.

WWF, 2011. Supply Chain Certification for Rattan in Laos: Soon a Reality but at What Cost? (Poster). IKEA/WWF. 1 page.

WWF, 2013. Sustainable Rattan Supply Chain from Lao PDR. Annual Progress Report. Financial Year 2014 (1 September 2013 – 30 June 2014). Compiled by Bouavanh Phachomphonh and Matthew Markopoulos. 27 pages.

WWF, 2014. Annual Progress Report. Sustainable Rattan Supply Chain from Lao PDR. Financial Year 2014 (1 September 2013 – 30 June 2014). WWF Laos and WWF Greater Mekong. 26 pages.

BROOM GRASS

Alan M.J., Ali M.R., Sarmin N.S., Miah M.M.U. and M. Shahjahan, 2013. Existing Marketing System and Economic Analysis of Broom Grass (Thysanolaena maxi Roxb : Poaceae). Journal of Agroforestry and Environment, 7 (1): 81-84, 2013. 4 pages. (Note: this study was conducted in Bangladesh)

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

TABI/CDE NTFP database on broom grass from a survey in 133 villages.

Thanhyapheng T., Xayxomphou B., 2013. Report on Broom Grass Value Chain Study in Khoua District, Phongsaly Province. Northern Uplands Development Programme (NUDP), August 2013. 30 pages.

Tiwari B-K., Shikla R.P., Lynser M.B. and Tynsong H., 2012. Growth Pattern, Production, and Marketing of Thysanolaena maxima (Roxb.) Kuntze: An Important Non-Timber Forest Product of Meghalaya, India. Forest, Trees and Livelihoods, Vol. 21, No 3, September 2012, 176-187. 14 pages.

Shankar U., Lama S.D. and Barkwa K.S., 2001. Ecology and Economics of Domestication of Non-Timber Forest Products: An Illustration of Broomgrass in Darjeeling Himalaya. Journal of Tropical Forest Science 13(1): 171-191 (2001). 21 pages.

Other source consulted: Article on broom grass cultivation in Hin Heup published in the Vientiane Times January 20, 2015.

CRISPY RIVER WEED

Foppes N., 2012. Assisting Women Producer Groups of "Khai Pean" River Weed Food in Luang Prabang Province. Nongnut Foppes, Xaoban Group. 27 pages.

TABI Newsletter Issue No.3, June 2013 "Crispy River Weed Quality Improvement and Marketing" Page 5. (Note: this one-page article includes a good presentation of the key steps involved for making the dried river weed sheets of Khai Paen).

TABI SPA 006: Crispy River Weed production and Quality improvement for marketing (Phoukoud district, Xieng Khouang province).

TABI SPA 032: Crispy River Weed Processing and Marketing (4 districts in Luang Prabang province).

WILD MUSHROOMS

Mortimer P.E., Karunarathna S.C., Li Q., Gui H., Yang X., Yang X., He J., Ye L., Guo J., Li H., Sysouphanthong P., Zhou D., Xu J., Hyde K.D., 2012. Prizable Edible Asian Mushrooms: Ecology, Conservation and Sustainability. Fungal Diversity. 17 pages.

Mortimer P.E., Xu J., Karunarathna S.C. and K.H. Hyde, 2014. Mushrooms for Trees and People: A Field Guide to useful Mushrooms of the Mekong Region. The World Agroforestry Centre (ICRAF), East Asia, Kunming, China. 125 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Pedersen O.S., Thammavong K., 2014. Wild Mushrooms: Edible and Medicinal Species, Local Knowledge and Use. Pilot Survey in Bong, Mixay, Yay Lethong, Gnordphe and Boua-Xay villages, Phoukoud District, Xieng Khouang Province, Lao PDR. GEF/UNDP/FAO-MAF ABP: Agro-biodiversity Project. 13 pages.

Phengsintham P. and K.D. Hyde, 2003. Checklist of Lao fungi. Building capacity in Biodiversity Information Sharing 2003, Tsukuba, Japan, 184-190. (Also article: Fungi of Laos: Ascomycetes from Palms).

Phengsintham P., Chukeatirote E., Hyde K.D. and U. Braun, 2011. Mycology in Laos. Newsletter of the Asian Mycological Committee Meeting, 2011.

TABI, 2014. Chomphet District: data on mushroom collection and income in 8 villages (tables).

TABI Update Issue No 4, February 2014. Mushroom species and collecting surveyed in Chomphet district, Luang Prabang province. Pages 1 and 2.Tapinghae T., 2005. Mushroom Growing in Lao PDR. Mushroom Growers Handbook 2. Pages 244-260. 16 pages.

Thavatdy T., Sykham B. and V. Saliyavong, 2008. Report on Diversity of Mushrooms in Dongmakkhai Village, Xaythany District, Vientiane Municipality and Mai Village, Xai District, Oudomxay Province. BSc Report, Faculty of Science, NUoL.

HONEY

ADB/IFAD. SNRMPEP. Conservation of Wild Honey Bees with Production of Honey for the Poor Farmers in Pathumphone district, Champassack province. CPA/NRM/02. 3-year sub-project.

Akratanakul P., 1990. Beekeeping in Asia. FAO Agricultural Services Bulletin 68/4. FAO, Rome.

Association for Sustainable Beekeeping, Oudomxay, 2013. Creating Sustainable Livelihoods through Community Beekeeping. Narrative Report January-May 2013 (available on the web, not in PDF).

Chin PH, 1994. Production of Honey and Beeswax in Sekong province, southern Laos. In J.de Beer (ed.) Our Life depends on nature. Novib, The Hague pp. 19-21, 41, 59-61. Non-Timber Forest Products in Conservation and Community Development in Lao PDR.

Data from Beekeeping in 2014 in the Phousan area, Xieng Khouang (non-TABI project).

Data on beekeeping from the Lao Census of Agriculture 2010/11 – Lao DECIDE Info.

Koetz A., 2013. The Asian honey bee (Apis cerana) and its strains – with special focus on Apis cerana Java genotype. Literature review. Queensland State Department of Agriculture, Fisheries and Forestry, Australia. 59 pages. (Note: contains a lot of useful information on the Asian Honeybee "Apis cerana", the main species raised by Lao beekeepers).

TABI Update No3, June 2013. Bee Keeping and Honey Production on Increase in Xieng Khouang.

Sengngam B., Vandame J., 2005. Développement de l'apiculture au Laos: différents choix stratégiques. Université Nationale du Laos - Nabong (NUoL) et CCL – Projet d'Appui à la Faculté d'Agriculture (PAFA). 57 pages. (Note: This is the most comprehensive report on beekeeping in Laos and it was also translated in English under the title: Development of Beekeeping in Laos: Various Strategic Choices).

TABI Update No4, February 2014. "Plain of Jars honey hits the shelves."

TABI, 2014. File on SPA 004: Promotion of improved native bee beekeeping (Nambak & Chomphet districts, Luang Prabang province)

TABI, 2014. File on SPA 025: Local Bee Keeping Promotion (Pek district, Xieng Khouang province)

Vandame J., 2006. Conservation and Management of Pollinators for Sustainable Apiculture through the Ecosystem Approach. An In-Depth Review of Existing Information in Lao PDR. FAO.

Websites on bees and beekeeping: www.laojunglehoney.com (website of Gerry Veley).

FISH FROM CONSERVATION ZONES

Cacaud P., Latdavong P., 2009. Fisheries and aquaculture in the Lao PDR. A Legislative Review. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. RAP Publication 2009/05. 83 pages.

Phonvisay S., 2013. An Introduction to the Fisheries of Lao PDR. Mekong Development Series No 6, Mekong River Commission. 64 pages. (Note: this document gives a good and well-illustrated overview of fisheries in Laos, compiled by the well-experienced former Director General of the Department of Livestock and Fisheries of MAF).

Poulsen A.F., Hortle K.G., Valbo-Jorgensen J., Chan S., Chhuon C.K., Viravong S., Bouakhamvongsa K., Suntornratana U., Yoorong N., Nguyen T.T., and Tran B.Q., 2004. Distribution and Ecology of Some Important Riverine Fish Species of the Mekong River Basin. Mekong River Commission, MRC Technical Paper No 10. 116 pages.

Saphakdy B., Phonekampheng O., Bouapao L., Hortle K.G., ---. MK19 Fisheries and Aquaculture Production in Reservoirs in Lao PDR. CGIAR-CPWF/MDC/MAF/LARReC/NUoL. 19 pages. (Note: this document briefly describes the project mentioned in the title).

TABI, 2014. Files of SPAs 19, 34, 41, 44, 45 and 57 on fish conservation zones in Luang Prabang province.

FISH IN RICE FIELDS

Funge-Smith S., 1998. Small-scale Rural Aquaculture in Lao PDR. Provincial Aquaculture Development Project (LAO/97/007). 16 pages.

Halwart M., Gupta M.V. (editors), 2004. Culture of Fish in Rice Fields. FAO and CGIAR/WorldFish Center, Rome. 83 pages.Phonvisay S., 2013. An Introduction to the Fisheries of Lao PDR. Mekong Development Series No 6, Mekong River Commission. 64 pages.

TABI, 2014. File of SPA 30 on fish in rice fields (Xam Neua and Viengxay districts, Huaphan province).

MEDICINAL PLANTS

Anonymous,--. Traditional Medicine in Lao PDR. 14 pages. (Booklet)

Libman A. et al., 2008. A First New Antimalarial Preg-

nane Glycoside from Gongronema napalense. Asian Journal of Traditional Medicine.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Pierce Salguero C., 2005. A Thai Herbal. Traditional Recipes for Health and Harmony. Silkworm Books, Chiang Mai, Thailand. 188 pages.

Reid D., 1995. A Handbook of Chinese Healing Herbs. An easy-to-guide to 108 Chinese medicinal herbs and dozens of prepared herbal formulas. Simon & Schuster, London. 328 pages.

Riley M., 2000. The Traditional Medicine Research Center (TMRC). A Potential Tool for Protecting Traditional and Tribal Medicinal Knowledge in Laos. CSQ Issue: 24-4 (Winter 2000) Intellectual Property Rights.

Soejarto D.D., Gyllenhaal C., Kaduhin M.R., Southavong B., Sydara K., Bouamanivong S., Xaiveu M., Zhang H.J., Franzblau S.G., Tan G.T., Pezzuto J.M., Riley M.C., Elkington B.G., Waller D.P., 2012. An Ethnobotanical Survey of Medicinal Plants of Laos toward the Discovery of Bioactive Compounds as Potential Candidates for Pharmaceutical Development. Pharm. Biol. 2012 January; 50(1): 42-60. 18 pages.

Sydara K., 2007. Environmental Impacts of Trade Liberalization on the Medicinal Plants & Spices Sector of the Lao PDR. Background research paper, Rapid Trade and Environment Assessment (RTEA), International Institute for Sustainable Development (IISD). 17 pages.

Sydara K., 2014. Status, Utilization, Management and Development of Medicinal Plants in the Lao PDR. Institute of Traditional Medicine, Ministry of Health. Sub-sector Working Group on Agro-Biodiversity (SWG ABD) under the Sector Working Group on Agriculture and Rural Development. June 10, 2014. 14 pages.

TABI, 2014. File on SPA 048: Local Medicine Knowledge Strengthening and Quality Improvement in relation to ABD Conservation (Phoukoud district, Xieng Khouang province).

TABI Update Issue No 2, November 2011. "Traditional Medicine protects Biodiversity". An Overview of Medicinal NTFPs in the Lao PDR. Page 1. "Growing Medicines". Medicinal Plants Sub-project – Luang Prabang. Page 2.

WILD SUGAR PALM (MAK TAO)

Chantaraboon A., Burikam I., Pampasit S., Pongsattayapipat R., 2009. Improvement of Sexual Propagation in Sugar Palm (Tao) (Arenga westerhoutii Griff.) Seeds. Thai Journal of Agricultural Science 2009, 42(3): 67-70. 4 pages.

Chantaraboon A., Burikam I., Pampasit S., Pongsattayapipat R., 2010. Method for the Economic Recovery of Sugar Palm (Tao) (Arenga westerhooutii Griff.) Community Forests. Songklanakarin Journal of Science and Technology 32 (4), 357-362, Jul-Aug 2010. 6pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Veunkham O.V., Panyasiri S., Sipaseuth V., Keovankham S., 2014. Survey on Natural Resource Availability of Maktao Wild Sugar Palm around Hin Nam No NPA, 28 May-5 June 2014. Agro-forestry Consultant Company Limited, Vientiane. Report to IP Consult, GIZ Integrated Nature Conservation & Sustainable Resource Management in the Hin Nam No Region. 35 pages.

Website: www.palmpedia.net/wiki/Arenga_westerhoutii (Note: this site contains a general description of the sugar palm tree species and is well illustrated with photos)

GENERAL

ABP, 2014. 13th Field Visit Project. Phoukhout District, Xieng Khouang Province. Follow-up on field activities. October 14-17, 2014. UNDP/FAO Agro-biodiversity project (ABP). 4 pages.

Callaghan M., 2003. Checklist of Lao Plant Names. Vientiane. 212 pages.

CIP-UPWARD, 2003. Conservation and Sustainable Use of Agricultural Biodiversity: A Sourcebook. International Potato Center – User's Perspectives With Agricultural Research and Development. Los Banos, Laguna, Philippines. 3 Volumes.

De Beer J.H., 1993. Non-Wood Forest Products in Indochina. Focus: Vietnam. Working Paper, FO:Misc/93/5. FAO, Rome. 47 pages.

Foppes J., Ketphanh S., 2000. Forest Extraction or Cultivation? Local Solutions from Lao PDR. Paper for FOREASIA Workshop, Lofoten, Norway. 16 pages.

Foppes J., Samontry D., 2010. Technical Report: Assessment of the values of Non-Timber Forest Products (NTFP) in Lao PDR. Ministry of Agriculture and Forestry, Department of Forestry. 42 pages.

Gardette E., Kanyavong K., 2014. National Agricultural Biodiversity II Programme in Lao PDR (Second Draft). FAO in Lao PDR. 87 pages.

GDS, 2013. Soum Son Seun Jai, the Community-Based Food Security and Economic Opportunities Program: Market Analysis and Implementation Guide. Report prepared for IFAD by Global Development Solutions, LLC, January 25, 2013. 95 pages. (Note: This report contains sections on Cardamom, Bitter Bamboo, Tea, Broom Grass and Sugar Palm Fruit).

Lao PDR, 2003. Biodiversity Country Report. MAF/STEA (with Danida and UNDP), Vientiane. 171 pages.

Lao PDR, 2004. National Biodiversity Strategy to 2020 and Action Plan to 2010. June 2004. 58 pages.

MAF, 2014. Lao Census of Agriculture 2010/11: Analysis of Selected Themes. Department of Planning and Cooperation, MAF, Vientiane. 170 pages.

NAFRI, NUoL, SNV, 2007. Non-Timber Forest Products in the Lao PDR. A Manual and 100 Commercial and Traditional Products. The National Agriculture and Forestry Research Institute. Vientiane, Lao PDR. 421 pages.

Neef A., Suebpongsang P., Manythong C., Tacheena W. and Kazuo O., 2010. Can Paper Mulberry Contribute to Building Sustainable Rural Livelihoods in Northern Laos? Southeast Asian Studies, Vol. 47, No 4, March 2010. 23 pages.

Newman M., Ketphanh S., Svengsuksa B., Thomas P., Sengdala K., Lamxay V., Armstrong K., 2007. A Checklist of the Vascular Plants of Lao PDR. Royal Botanic Garden Edinburgh, Scotland. 394 pages.

Phounvisouk L., Ting Z., 2014. Economics of NTFPs for the Ethnic Minority Livelihood: The Case of "Peuak Muak" in Northern Laos. Department of Development and Management, College of Humanities and Development, China Agricultural University, Beijing, China. International Journal of Agricultural Sciences and Natural Resources 2014; 1 (1): 13-23. 11 pages.

Steering Committee for the Agricultural Census – Agricultural Census Office, 2012. Lao Census of Agriculture 2010/11 Highlights. Department of Planning and Cooperation, MAF, Vientiane. 89 pages.

TABI, 2014. The Agro-Biodiversity Initiative (TABI-Phase 2) "promoting Lao ABD as driver for uplands development". Year 2 Progress Report: covering 1 July 2013 – 30 June 2014. SDC- NIRAS- TABI – MAF, Vientiane. 102 pages. (Note: This report contains a huge amount of quantitative data from TABI Sub-projects on various ABD products and was systematically consulted for the preparation of the fact sheets).

Vidal J., 1962. Noms Vernaculaires de Plantes en Usage au Laos. Ecole Française d'Extrême Orient, Paris. 210 pages.

Yokoyama S., 2002. The Livelihood System of the Population of a Mountainous Area in Northern Laos. A Case Study of Ngoi District, Luang Prabang Province. Researcher, National University of Laos. 39 pages.