

EDIBLE INSECTS IN LAO PDR:

BUILDING ON TRADITION TO ENHANCE FOOD SECURITY



Edible insects in Lao PDR: building on tradition to enhance food security

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and
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Foreword

Expanding populations and increasing purchasing power are placing ever-increasing demands on food production systems throughout the world. FAO estimates that global food production will need to expand by at least 60 percent from current levels to meet global food requirements in 2050.

To meet the challenge of feeding the world's expanding population, greater emphasis will clearly need to be given to increasing yields and overall production of traditional staple crops. But priority will also need to be given to increasing the production and consumption of currently under-utilized and under-appreciated foods.

The Lao People's Democratic Republic provides valuable experiences and lessons for other countries as it works to achieve sustainable food security and improve nutrition throughout the country. The country is advancing on these challenges by focusing on increased production of important cereal crops, particularly rice, while also highlighting the importance of diversified and nutrient-rich diets to overcome chronic malnutrition in some parts of the country, especially among young children.

Lao PDR is rich in tradition and culture, which is also well reflected in the country's food and eating habits. The country strives to build on these characteristics by recognizing and building greater appreciation for traditional foods, while simultaneously welcoming and introducing modern food production and consumption practices. This mix of 'old' and 'new' presents both challenges and opportunities in addressing food security and nutrition issues.

The percentage of the population of Lao PDR that regularly consumes insects is among the highest in the world. Recognizing that edible insects provide many health, nutrition, environmental and livelihood benefits, recent efforts have been made to build upon these traditions and increase awareness and appreciation of the benefits of edible insects. FAO is pleased to have supported these efforts, particularly through the *Sustainable insect farming and harvesting for better nutrition, improved food security and household income generation in Lao PDR* Project (TCP/LAO/3301), implemented from 2010 to 2013.

Most edible insects in Lao PDR are collected from wild habitats, but recent efforts – including those supported by FAO – have been made to introduce technologies for sustainable farming of selected insect species. Additionally, support has been provided to ensure food safety, improve processing and handling practices and develop more efficient marketing and trade of edible insects.

Other countries can learn from the valuable experiences of Lao PDR in building on traditional practices – while simultaneously introducing enhanced technologies and new approaches – to address food security and nutrition challenges in a multi-pronged manner. By documenting

Lao PDR experiences related to edible insects in this publication, FAO hopes others will benefit and be motivated to identify similar opportunities. Indeed, there are numerous opportunities across the region to more fully and effectively incorporate a vast array of under-utilized and under-appreciated foods in national food security and nutrition strategies.

FAO encourages other countries to consider the Lao PDR experience as presented in this publication. Food security in the future will require contributions from many sources – modern and traditional, old and new. FAO stands ready to facilitate the further exchange of information and technology related to these issues and challenges.



Hiroyuki Konuma
Assistant Director-General and
Regional Representative



Mixed weaver ant larvae and pupae being sold at a market in Champassak province.

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- *Edible insect survey in Laos, main findings* by Hubert Barennes (2010), produced for Institut de la Francophonie pour la Médecine Tropicale, with funds provided by FAO.
- *Sustainable insect farming and harvesting for better nutrition, improved food security and household income generation* by David Mann (2010).
- *Retail outlet survey in Vientiane, Lao PDR* by Tollard Ninon (2010).
- *Food safety aspects of edible insects in Vientiane, Lao PDR - a microbiological approach* by Harmke Klunder (2010).
- *Edible insects in Lao PDR, collection practices and perspectives for sustainable use* by Océane Mergaert (2011).
- *Edible insects in Vientiane, Lao PDR. – a microbiological approach on food safety and food processing* by Eline Vranken (2011).
- *Qualitative survey on insect collection in Lao PDR* by Charlotte Spinazze (2011).
- *Insect consumption among children under 2 and breastfeeding women of different Lao ethnic groups* by Maria Quaglietta (2011).
- *Report on stocktaking survey for edible insect trainees* by Avakat Phasouysaingam (2013).
- *Survey and data collection on the Lao edible insect production, market and trade.* by Yupa Hanboonsong and Yoawarat Sriratana (2013)

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Collecting grasshoppers with sweeping net at Beung That Luang wetlands in Vientiane.

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Adult weaver ants crawling up to their nest.

Executive summary

The Lao People's Democratic Republic (Lao PDR) is a rugged, mountainous, landlocked country, with relatively weak infrastructure. As such, the country faces numerous challenges in achieving sustainable food security and nutrition for all its citizens. Concerted efforts of recent years have resulted in significant advances in ensuring food security, but serious challenges remain – particularly related to improving nutrition.

The Food and Agriculture Organization of the United Nations (FAO) supported the Government of the Lao PDR in its objectives to improve overall national nutrition through the three-year *Sustainable insect farming and harvesting for better nutrition, improved food security and household income generation in Lao PDR* Project (TCP/LAO/3301) that started in April 2010. The project aimed to strengthen the existing role of insects in the Lao diet; enhance the sustainability, safety and efficiency of current harvesting, preparation and post-harvest processing practices; further stimulate insect consumption nationwide; and promote edible insect farming.

Lao people have always eaten insects, which they generally regard as *saep laai laai* (delicious). The percentage of the Lao population that regularly consumes insects is among the highest in the world. Until recently, local people have been relatively unaware of the significant nutritional (and other) benefits of eating insects, which can provide essential macronutrients and micronutrients that are frequently lacking in diets (especially for children).

The most preferred and frequently consumed insects in Lao PDR are weaver ant larvae and pupae, wasps, bamboo caterpillars, short-tailed crickets, house crickets, grasshoppers and cicadas. Most edible insects in Lao PDR have traditionally, and until now, been collected from wild habitats, and local people possess a rich body of traditional knowledge related to harvesting practices, timing of collection and management of insect resources.

The farming of edible insects is a relatively new phenomenon in Lao PDR. Two cricket species, the domestic house cricket (*Acheta domesticus*) and the common cricket or field cricket (*Gryllus bimaculatus*), are now regularly farmed. The domestic house cricket is slightly more popular than the common cricket. They can be farmed year round and are therefore the most common insect species found in local markets.

Insect marketing is difficult to analyse in Lao PDR. The vast majority of Lao households collect and consume edible insects, but only a small proportion of the total insect supply is offered for sale and unlike in neighbouring Thailand, they are not generally traded by vendors. A relatively small proportion is transported and sold in other provinces or the capital city.

This publication compiles selected research findings produced by the FAO-supported project aimed at enhancing nutrition and food security in Lao PDR. It features information on both traditional insect harvesting practices as well as modern farming of insects, introduced by the FAO-supported project. It also introduces Lao PDR experience related to food safety of edible insects, processing, handling, marketing and consumption.



Collecting bamboo caterpillars in Xiengkhouan province

Introduction

The Lao People's Democratic Republic (Lao PDR) shares borders with Cambodia, China, Myanmar, Thailand and Viet Nam. It has a tropical monsoon climate characterized by a rainy season from May to October, a cool dry season from November to February, followed by a hot and dry season from March to April. More than two-thirds of the 6 million inhabitants live in less developed rural areas and more than one-quarter of the population lives below the national poverty line of approximately US\$1.5 a day (WFP 2007). Agriculture is dominated by rice cultivation. Despite being an agriculturally self-sufficient country, food scarcities exist periodically in various locations, usually in mountainous areas. A considerable portion of land remains uncultivated owing to the presence of unexploded ordnance, generated from the war in Viet Nam in the 1960s and 1970s, which inhibits crop production. Floods and droughts have negative impacts on agricultural activities annually.

Collecting insects, for home consumption or sale, is a traditional activity in Lao PDR, where at least 50 insect species are eaten throughout the year. The most preferred and frequently consumed insects are: (1) weaver ant larvae and pupae; (2) short-tailed crickets; (3) crickets (house and common crickets); (4) grasshoppers; and (5) cicadas (Barenes 2010). Most of the edible insects are caught in the wild, during harvesting crops or while working in agricultural fields and nearby forests (Yhoung-aree and Viwatpanich 2005). Forests cover more than 47 percent of the geographical landmass in Lao PDR (Sisouphanthong and Taillard 2000). Although forest resources are more extensive than in neighbouring countries, various species of flora

and fauna are endangered or threatened (Strigler and Le Bihan 2001). Non-wood forest products (NWFPs), including edible insects, provide 50 percent of the monetary income of many rural villages, where 80 percent of the population lives. The local use of NWFPs to sustain livelihoods has been estimated to comprise 20 to 30 percent of the gross national product (Foppes and Dechaineux 2000). Insects are generally considered to be 'forest products' by Lao people. Indeed, some insects such as common skimmer larvae, giant water bugs or grasshoppers are primarily caught in forest streams, wetlands and paddy fields close to forests.

There is an acute need to improve diets in Lao PDR because of serious malnutrition in several provinces. The rates of malnutrition are among the highest in Southeast Asia; 40 percent of Lao children under the age of five are severely undernourished. Protein and energy deficiencies are common, and are exacerbated by low levels of micronutrient intake, such as vitamin A, iron, iodine and vitamin B1 (WFP 2007).

Edible insects provide high amounts of protein, fatty acids, vitamins and minerals and are a promising alternative to conventional protein sources. As most people in Lao PDR consume insects at least occasionally (Barenes 2010), there is good reason to believe that promoting insect consumption can help combat malnutrition, alleviate food insecurity and generate new sources of income in the country. Moreover, edible insects are considered to be *saep laai laai* (delicious) by most Lao consumers, and thus are considered a preferred food item.

Within this context, FAO supported the Lao Government in its objectives to improve nutrition through the three-year “*Sustainable insect farming and harvesting for better nutrition, improved food security and household income generation in Lao PDR Project (TCP/LAO/3301)*”. The project started in April 2010 and concluded in April 2013. The project aimed to strengthen the existing role of insects used in the Lao diet; enhance the sustainability, safety and efficiency of harvesting, preparation and post-harvest processing practices; further stimulate insect consumption nationwide; and promote edible insect farming.

The primary outputs of the project were:

- Documentation of existing knowledge and practices related to edible insects in Lao PDR; gaps and opportunities prioritized;
- Increased awareness and appreciation for sustainable insect production, harvesting from natural habitats and consumption;
- Introduction of viable insect farming practices; and
- Development of sustainable practices for insect harvesting from natural habitats.

The project’s activities related to insect rearing focused on four insects: domestic house crickets, weaver ants, palm weevils and mealworms. Except for mealworms, these insects have traditionally been consumed by Lao people according to availability. The mealworm is more typically used as animal feed, although the project also introduced it as a potential human food. The cost of production of these insects is relatively modest and they are generally easy to rear. The project provided basic investment for farmers and extension workers, including cricket eggs, feed and other essential materials.

These four species of insects are now produced at the project established Edible Insect Demonstration Unit, at the Faculty of Agriculture, National University of Lao PDR (NUoL). House cricket, mealworm and palm weevil are bred in enclosures at the unit, while weaver ants are managed in a semi-domesticated manner on orchard trees outside the unit.

At the Edible Insect Demonstration Unit, experiments have also been undertaken to determine the favourable feed options (with respect to nutritional and financial aspects) for the insects, and recommended management practices.

A stocktaking survey of cricket farms in Lao PDR was conducted at the close of the project. The report is useful for updating the status of insect farming, income and constraints of farmers.

A great number of insect species, and considerable quantities of insects, are collected from wild habitats in Lao PDR. However, these valuable natural resources are subject to human-induced and climatic pressures. Intensive, excessive or unsustainable collection practices could result in reductions in insect populations, weakening the regeneration potential of local populations, and reducing the availability of insects for food over time. The FAO-supported project therefore also included components related to ‘sustainable insect harvesting’ to help enhance long-term viability of insect harvests from the wild and maintain the cultural heritage of insect collection.

Until recently, very little was documented about edible insect species collection methods and consumption patterns in Lao PDR. This publication is intended to highlight information about edible insect consumption in Lao PDR (including people’s preferences), health benefits of eating insects, harvesting practices and the potential for expanding edible insect farming to further boost national nutritional requirements, improve food security and generate income. The publication draws upon and synthesizes project experiences and various unpublished project reports.



edible adult cicadas

Overview of edible insect collection

Insects represent an essential part of the food chain and are an important food source for birds, reptiles, humans and other insects. Wild harvesting of insects for human consumption entails various challenges. The small size of most insects can present difficulties in collection, processing and marketing. The seasonality of many wild insect populations also constrains the ability of collectors to earn income on a regular basis.

Habitat loss remains the biggest threat to insect biodiversity. In Lao PDR, logging and shifting cultivation are perennial threats to insect diversity. Interestingly, not all human disturbance is harmful to particular insect species. Some species, in fact, require landscape disturbance to survive. The opportunists (for example ants and dung beetles) are most likely to flourish in the transition from natural forests to agricultural use of land.

It is not known precisely how many edible insect species are consumed in Lao PDR. But according to Nonaka *et al.* (2008), at least 30 popular edible insect species are sold in the Vientiane capital alone. Traditionally, most edible insects have been collected from natural habitats, mainly in rural areas. Knowledge of insect species that can be eaten and practices for collecting them are based on cultural and traditional practices, experiences and beliefs. Edible insect harvesting is mostly undertaken by individuals and families for non-commercial household consumption. Insect harvesting is undertaken by men and women equally and sometimes even by children if the tasks are not too difficult. Some collection practices, however, are considered too dangerous for children. Collection of cicadas, for example, is considered too difficult for children since they reportedly stay very high in trees. Similarly, collecting hornet larvae may be considered too dangerous for children.

Different locally made tools such as nets, baskets, bamboo sticks or glue are used to catch insects based on their life cycles and habitats. For example, aquatic insects such as predaceous diving beetles, backswimmer beetles and water scavenger beetles are collected using fishing tools such as a dip-net (Lao: “Sa-wing”) or a bamboo woven basket (Lao: “Kheong”). Many popular edible insect species (e.g., cicadas, stink bugs and weaver ants) are collected from trees, using simple tools such as bamboo sticks and bamboo baskets, or are simply handpicked from the trees.

The timing of insect collection depends on the insect’s behaviour and life cycles. Some insects, such as grasshoppers, are less active and thus easier to capture at low temperatures – mostly in early morning or at night time. Other species such as cicadas and crickets can be located by their stridulating sound. Aquatic insects can be collected all year round but peak collection is generally in the rainy season (June to August) .

Night flyers such as the giant water bug and various beetles are attracted by light and caught in nets or traps. In Vientiane, a piece of corrugated iron with lights at the top and a small water basin at the bottom is commonly used for collecting giant water bugs (see Figure 1).

Knowledge about insects is indispensable and imparted from one family member to another, and generation to generation, mostly from parents to children. It is interesting to note that in some places, certain insects are commonly available but are not collected, since people have apparently not been taught to collect them.

Seasonal availability

As with other wild food resources, the availability of insects varies with temperature, precipitation and forest crown cover. In the northeast of Lao PDR, the rainy season months of June and July are the best time of year to harvest many species of insects, including termites, mole crickets, short-tailed crickets and several species of beetles (Table 1). Other insects such as grasshoppers, bamboo caterpillars and dragonflies are only available in the cold and dry season months from November to January.

Table 1. Insect availability from the field, Nam Meung, Xiengkhouan Province, Lao PDR

Insect's name			Months												
English	Lao	Scientific	1	2	3	4	5	6	7	8	9	10	11	12	
Grasshoppers	Tak Tane	<i>Locusta migratoria</i> <i>Euconocephalus</i> sp. <i>Mecopoda elongate</i>													
Termites	Mak Phua	<i>Macrotermes</i> spp.													
Termites	Mak Khon	<i>Odontotermes</i> spp.													
Bamboo caterpillar	To Mir	<i>Omphisa fuscidentalis</i> Hampson													
Wasps	ToKhea(yellow)	<i>Vespa</i> spp.													
Wasps	To Dun(black)	<i>Vespa</i> spp.													
Dragonflies	Meing Naa Gam	Order Odonata													
Mole Cricket	Mieng Xone	<i>Gryllotalpa africana</i> Palisot & De Beauvois													
Short-tailed Cricket	Chi Nai	<i>Brachytrupes portentosus</i> Lichtenstein													
Stink bug (1)	Mieng khieng	<i>Tessaratomia quadrata</i> Distant													
Cockchafer (beetles)	Mieng Chi Noun	<i>Holotrichia</i> sp.													
Horned beetle	Mieng Kham	<i>Xylotrupes gideon</i> L.													
Cicadas	Chak Chan	<i>Cicadidra</i> spp.													
Giant water bug(2)	Mieng Daa	<i>Lethocerus indicus</i> Lepeletier & Serville													

(1) Mieng khieng are collected all the year but it is easier to collect during the months of May and June

(2) Giant water bugs are collected all the year. According to the villagers, the collection is nevertheless easier during the dry season since the water level is lower. Source: Mergaert and Sosamphan (2010)



Figure 1 (a) grasshoppers collector; (b) digging for soil edible insects; (c) short tailed crickets from underground collection; (d) giant water bugs; (e) corrugated iron with lights trap for giant water bugs collection;

Some common edible insects

Bamboo caterpillar

(Pyralidae: *Omphisa fuscidentalis* Hampson)

Lao name : *To Mir or Daung Nor Mai*

General description

The bamboo worm or bamboo caterpillar is the larval stage of the moth *Omphisa fuscidentalis*, which has an annual life cycle. The bodies of the worms are white, 3 to 4 centimetres long and they inhabit bamboo culms.

Adults appear in early August and mate during the night. Females lay from 80 to 130 white eggs at the bases of bamboo shoots. The newly hatched larvae bore a hole into the shoots, enter an internode and feed on the inner pulp.

One day after entering the culm, the larvae bore an exit hole for adult emergence between the fifth and tenth internodes. After 45 to 60 days, the larvae congregate in the internode where the exit hole was bored. Eight months later the larvae start to pupate. The pupal period ranges from 46 to 60 days and pupation occurs in the dividing wall of the internodes. The adults emerge from the culm through the exit hole from July to August.

Collection method

In Xiengkhouang Province, bamboo worms are collected from October to January. Collection generally takes place in forests in the morning but also occasionally occurs at other times.

Collection is a simple process and only a knife and some experience are needed. Bamboo culms are slashed and the worms are gathered by hand or kept on a leaf for subsequent storage in a bamboo culm.

According to villagers, the two main criteria for locating worms are thinner bamboo culms and shorter internodes.

One bamboo shoot generally contains between 40 and 50 bamboo worms (400 bamboo worms constitute approximately 1 kilogram).



a.



b.



c.

Figure 2. (a) Inside of a bamboo culm; (b) gathering bamboo worms; (c) bamboo targeted by collectors

Cicada: nymph and adult stages

(Cicadidae: *Orientopsaltria* spp.,
Dundubia intermerata Walker)

Lao name: *Chak Chan*

General description

Cicadas belong to the Order Homoptera and the adults have a short life span. They spend most of their life underground as nymphs. For some species this can last for several years.

Cicada nymphs have strong front legs to extricate themselves from their underground habitat. Just before metamorphosing into adults they emerge from the soil through an exit tunnel that they have constructed. Their shells often remain attached to a plant for a long time after they have hatched.

Cicadas are herbivorous and feed on the sap of different plants, mostly woody species.

In order to attract females for mating, males 'sing' by vibrating membranes. Females do not sing. Each species of cicada has a distinctive noise. After mating, the female's ovipositor cuts into wood for egg-laying. Nymphs fall to the ground and burrow into the soil to feed.

Most cicada species have overlapping generations. This means that each year some of the nymph population emerges from the ground and forms a uniform and abundant new group of adults. In the case of non-overlapping generations, there are much longer periods during which adults cannot be found. For some species, this can be ten years or more.

Collection method

Cicada nymphs are harvested from November to March, while adults are collected from April to May. Two different species of cicada are commonly collected by villagers in Lao PDR. Cicadas have high financial value: 100 nymphs can be sold for 17 000 kip¹ whereas 100 adults are worth 12 000 kip.

Nymphs

Patience is needed for the collection of cicada nymphs. Approximately 500 nymphs can be gathered from dawn till dusk.

Usually collectors know which trees to target for cicada hunts and where they can be found. Cicadas like to live in capacious, perennial trees rather than bushes or small trees.

One way of identifying adult cicada presence is by looking out for wet/damp patches on the ground surface around a tree trunk. These patches are caused by adults defecating in the tree above while eating.

To find nymphs, the soil around trees is dug out and one small hole usually contains one nymph.

Adults

Adult cicadas are collected during the hottest months of March and April. A long bamboo pole (\pm 5 metres) with a small bamboo appendage at the end smeared with glue is used to collect cicadas. Called *yang tang*, the glue is a mixture of two different resins from *Dipterocarpus* spp. and *Ficus* spp. Several cuts are made in the trees to collect the resins separately in small bamboo culms. The resins are mixed until they are sticky enough.

Cicadas are collected at any time during the day and even at night. However, collection is easier during the hottest time of the day when the stridulations are loudest. The glue is prepared beforehand and when the first stridulations are heard collectors venture into the forest for harvesting.

It is essential to remain absolutely silent during collection as any noise will scare the cicadas away. The cicadas can be easily identified despite their excellent camouflage which mimics tree bark. Once the cicada(s) are located, they are slowly approached with the bamboo pole and the cicada is trapped on the glue by its wings. After harvesting they are cleaned to remove the glue before consumption.

In the peak season, 80 cicadas can be collected in approximately one hour, usually when there are many cicadas in the same tree.

¹ US\$1.00 = 8 031 Lao kip.



Figure 3A. (a) cicada nymph collector; (b) cicada nymphs; (c) basket for gathering the nymphs; (d) cooked cicada nymphs dish



Dragonfly larvae (Libellulidae, Aeshnidae, Gomphidae)

Lao name: *Mieng Naa Gam*

General description

Dragonflies are insects belonging to the Order Odonata and there are almost 10 000 species worldwide. They have three stages during their life cycles. The eggs hatch into nymphs that can experience up to 15 periods of metamorphosis before emergence as adults.

The immature stages are aquatic and the nymphs bear no resemblance to the adults. The adult stage is generally the shortest in the life cycle. Females deposit their eggs in flowering plants, floating vegetation or directly into the water. Dragonfly nymphs develop in the water and take months or even years to develop to maturity. The nymphs, which are the only form of development fit for human consumption, have large eyes and are often quite flat on their undersides. Adult dragonflies are useful predators and feed on mosquitoes, flies and other flying insects.

Collection method

Dragonfly nymphs are rarely sought specifically, but are often collected during periods of foraging for other aquatic fauna such as fish or crabs. They are mainly found in still waters, but also in rivers such as the Mekong. Once collected with the help of a net, they are kept in a metal container.



Figure 4.

(a) collecting dragonfly nymphs with a net;
(b) dragonfly nymphs;
(c) dragonfly nymphs sold with other small fishes in the market

Dung beetle

(Scarabaeidae: *Onitis* spp., *Copris* spp., *Heliocopris* spp.)

Lao name: *Chud Chii*

General description

Dung beetles belong to the Order Coleoptera which constitutes one of the main groups of insects. Dung beetles and their larvae are coprophagous (partly or only existing on animal faeces) or necrophagous (existing on dead animals). Thanks to these idiosyncrasies they fulfil a major environmental role primarily by preventing the accumulation of dung, fertilizing the soil by rapidly burying dung, decreasing the multiplication of the intestinal parasites of cattle and facilitating the decomposition of carrion.

There are various species of dung beetle. Most of them belong to the Aphodiinae and Scarabaeidae subfamilies. Aphodiinae live in the dung while Scarabaeidae fractionate and transport it.

These beetles fly and locate feed through their highly developed sense of smell. As soon as they locate dung they settle and feed on it. Males and females couple and construct a nest together.

Adults move some parts of the dung to fill the crevices located at the extremity of their underground galleries by building balls of dung that are rolled and buried in the cavities. Underground reserves are used for feeding or nesting. Nests contain enough feed for the development of the larvae until the adult stage. Their nesting architecture is highly diverse and consonant with particular species, the season and the type of soil.

Although there are many species of dung beetle, only a few species of *Onitis* spp., *Liatongus* spp. and *Copris* spp. that live in buffalo and cattle dung, and the species *Heliocopris bucephalus* and *H. dominus* which live in elephant dung, are eaten.

Given the context of their mephitic habitats, it is essential that harvested beetles are cleaned thoroughly before consumption.

Only live beetles are collected and are placed into containers filled with water. The beetles then defecate to make themselves lighter to avoid drowning. The beetles are soaked for at least 12 hours in water or until no more food remains in their intestines. With another thorough washing, they are then ready for preparation for eating.

Collection method

In Lao PDR, dung beetles are usually found in dunghills created by buffalo in paddy fields. Thus, the quantity collected depends on the number of dunghills available.

Dung beetles are extricated with the help of a spade at a depth of approximately 10 centimetres. They are collected with care in order to not kill them.

One dunghill generally contains between three to ten beetles depending on the dung beetle species.



Figure 5. (a) Looking for dung beetles; (b) larva dung beetles in their element; (c) dung beetles sold in market

Green weevil or Gold-dust weevil (Curculionidae: *Hypomeces squamosus* F.)

Lao name: *Meng Xang* – ‘elephant insect’

General description

Adult green weevils are about 10 to 15 millimetres in length. They are easily recognized by their snouts, greyish colour and body surfaces, which are covered with shiny yellow or green scales. Green weevils are plant feeders. The larvae live in the soil and feed on living plant roots. The adults eat notches out of margins. Green weevils are associated with a wide range of host plants such as *Samanea saman*; *Cassia fistula*; *Casuarina junghuhniana*; *Tectona grandis* and *Xylia xylocarpa*. The species *Hypomeces squamosus* is common and widespread in Southeast Asia.

Collection method

Green weevils are collected during the months of March and April by handpicking the weevils at night after attracting them with lights. In addition, collectors may shake the branches of trees to knock the beetles down on the ground and then handpicking the felled beetles. According to villagers, green weevils are commonly found in specific trees such as *ton ngang soum* (*Calophyllum* sp.) and ton khoum (*Cassia fistula* L.).



Figure 6. (a) collecting green weevils at night; (b) kids eat cooked green weevils; (c) green weevils sold in market

Wasp larvae (Vespidae: *Vespa* spp.)

Lao: *Tor*

General description

Like bees and ants, hornets and wasps are social insects belonging to the Order Hymenoptera.

An individual hornet or yellow jacket queen begins building a nest by herself. Once a queen has produced enough workers to build the nest, she remains inside delivering more offspring. The workers expand the nest, feed the young and defend the territory. They continue to enlarge the nest until there are between 300 and 400 workers. Later, the colony will produce a reproductive brood, which will become the next queens; the role of the males is confined to mating. Nests are not reused the following year and are abandoned in favour of a new nest.

The two common edible wasp species are in the Vespidae family: the giant hornet (*Vespa affinis*) and digger wasp or hornet (*Vespa tropica*). The giant hornet is identified by its yellow banding on the first and second abdominal segments, and is quite aggressive. It builds its nest high up in trees. The digger wasp is moderately aggressive and it can be distinguished by a yellow band on the second abdominal segment. The nests are typically built inside enclosed spaces, including in the ground.

Most hornets and wasps provide an extremely beneficial service by eliminating many other insect pests through predation.

Collection method

Nests in the forest are collected during June, using meat as bait. Once a wasp is sighted, it is tracked to its nest, which is then brought back to the village after sedating the occupants.

Harvesting occurs at night when wasps are less active. Smoke is used to sedate the insects inside and outside the nest. After the nest is retrieved, aggressive wasps are despatched. It is not possible to estimate the size of the nest before uncovering it.

After collection, the best wasp larvae are selected for retail; typically about 3 kilograms of the best larvae are sold, fetching about 150 000 kip. The remainder is directly consumed by villagers.



Figure 7. (a) wasp larvae seller at Dong Makhai market in Vientiane; (b) live wasp larvae sold at the market; (c) pre cooked wasp pupae and larvae sold; (d) liquor fermented with adult wasp

Scarab beetle

(Scarabaeidae: *Holotrichia* sp. and *Phyllophaga* sp.)

Lao name: *Chi Noun*

General description

Beetles of the genus *Holotrichia* are referred to as ‘white grubs’ owing to their white larvae that are found under the soil where they feed on plant roots. Beetles belonging to the genus *Phyllophaga* are commonly named June bugs, May beetles or June beetles.

As adults, they mostly feed on leaves. Larvae feed on roots of trees, shrubs and herbs. *Phyllophaga* sp. is nocturnal but other species are diurnal.

Collection method

Scarab beetles are commonly collected during April and May. Villagers collect two species (one brown and one black) that live in the soil and on trees respectively.

The brown scarab beetles live in the soil near plant roots. Collectors search around small trees during daytime, digging down carefully to a depth of approximately 20 to 30 centimetres with the help of a small spade.

One hole generally contains two to three insects, but there can be up to 15 if the collector is lucky. Males and females are distinguished by pressing the end of the abdomen (soft for the males and hard for the females because of the eggs). Digging is much harder and less efficient than harvesting scarab beetles on trees, requiring much more effort and experience. Collectors generally need more than three hours to collect around 80 beetles using this method, whereas at night one tree can contain more than 20 beetles.

In collecting beetles from trees at night, a likely area is identified to hand-pick the beetles from trees with the help of a light. However, this has to be done quickly as the beetles may fly away if disturbed. Collectors can also use the technique of shaking the branches of a tree or entire trees if they are small. A large plastic sheet may be placed on the ground to catch the beetles as they fall. The tree species that are known to serve as hosts for scarab beetles include *Ormosia cambodiana*, *Diospyros* spp., *Pterocarpus macrocarpus*, *Pterocarpus pedatus* and *Lagerstroemia* spp.

After collection, the insects are kept in a bucket of water to be cooked the next morning. The forewings are removed before cooking.





Figure 8. (a) scarab collector; (b) scarab beetles attacking leaves; (c) the scarab beetle hold on their host tree; (d) adult scarab beetles; (e) Forewings were removed

Stink bug (Pentatomidae: *Tessarotoma* spp.)

Lao name: *Mieng Keng*

General description

Stink bugs belong to the Family Pentatomidae which includes almost 5 000 species worldwide. Most of the species are herbivorous. Pentatomidae are characterized by a flattened body. Stink bugs feed by sticking their tubular mouth parts into the plant tissue and have long piercing-sucking mouthparts like needles held under the body between the legs. Both adults and nymphs use their piercing-sucking mouthparts to feed on plant juice.

Stink bugs secrete a foul-smelling substance from pores on the sides of their bodies. This secretion helps to protect them from predators.

All stink bugs pass through three development stages: egg, nymph and adult. Females deposit their eggs on leaves and stems in clusters. After hatching, the wingless nymphs moult several times before becoming winged adults.

Collection method

Several species of stink bugs are consumed in Lao PDR. Stink bugs are often found around the leaves, and sometimes on the trunks or branches, of their food trees: *Schleichera oleosa* Oken and *Xerospermum laoticum*. Several methods are used for collecting. A long bamboo stick with glue attached at the end, similar to that used for collecting cicadas, is also employed in collecting adult stink bugs. But more often, a net attached at one end of a long bamboo stick is used. Other collecting methods entail throwing sticks into trees or shaking the tree branches, which dislodges some of stink bugs and causes them to fall to the ground. It takes a few seconds for the stinkbugs to become active again, so they need to be handpicked quickly.

Stink bugs are collected during the hottest time of the year (March to May). They are generally collected in the early morning and late afternoon,

but collection may also continue after dark using artificial light. During mid-day, the temperature is too hot and the stinkbugs tend to fly away quickly. Especially after rain, stink bugs are much less active and tend to stay in the trees, making it easy to collect them.

The fluid secreted by stink bugs is a defense chemical which colours collectors' hands yellow and leaves a strong smell; therefore, collectors usually cover their hands with plastic bags or plastic gloves.



Figure 9 (a) stink bugs sold in local market; (b) nymphs stink bugs soaking in water

Weaver ant (Formicidae: *Oecophylla smaragdina* F.)

Lao name: *Mot Deng*

General description

The weaver ant is an aggressive and territorial insect that builds ball-shaped nests with woven leaves of various tree species. Weaver ants use the silk derived from larvae (probably the final instar) to bind the leaves together (Offenberg *et al.* 2006). The green ants can colonize plant species with large leaves such as banana as well as species with smaller leaves such as twisted-cluster bean (*Parkia speciosa*) (Césard 2004). Weaver ants favour sunny habitats (Sribandit *et al.* 2008).

Weaver ant colonies may be founded by a single mated queen that finds a sheltered place to raise her first brood. The resulting workers take care of the next brood. Eggs and larvae are distributed to other nests. A single colony can cover up to 1 500 square metres (Sribandit *et al.* 2008).

Weaver ants are very effective in controlling other pests. Their positive role in orchards was first acknowledged in the fourth century in China (Césard 2004). This contribution has also been noted in cashew plantations, citrus orchards, cocoa and coconut plantations, and mango orchards. Recent research indicates that Vietnamese citrus farmers who nurture weaver ants in their orchards spend, on average, 50 percent less on agrochemicals compared with farmers without weaver ants in their orchards, while obtaining similar yields (Van Mele 2008).

Collection method

In Lao the term *Khai Mot Deng* is used to designate a mix of larvae and pupae of weaver ants. They are mostly collected between January and April. Collection normally occurs in the morning but sometimes continues into the afternoon. Collectors venture out specifically to collect ants but often collect other non-wood forest products such as fruits at the same time. Weaver ants make their nests in many different trees, such as jackfruit and mango.

Collectors can easily recognize nests containing large quantities of larvae and pupae. The size and the colour of the nests are two factors taken into consideration to select the nests to be harvested. Some nests may be too young and contain only a few eggs and larvae to be of interest to collectors. Some nests may be located too high up in trees, where queens are usually found, to be easily reached.

One collection method uses a bamboo basket tied by string to the end of a long bamboo pole (± 4 metres). A small branch is put inside the basket to ensure that it remains open. The bamboo basket is placed under the nest and the pole is shaken to make the ants fall into the basket.

When the larvae and pupae have been collected from the nest, the basket is lowered to the ground. To prevent the ants from biting and to separate the adults from the eggs, tapioca (cassava) starch is poured over the basket. Then the basket is emptied onto a metallic plate and blowing or shaking of twigs are used to separate out the adults. When the adults have been removed, the eggs are placed in a plastic basket. The size of the larvae and the pupae collected can differ and even winged ants are sometimes collected.

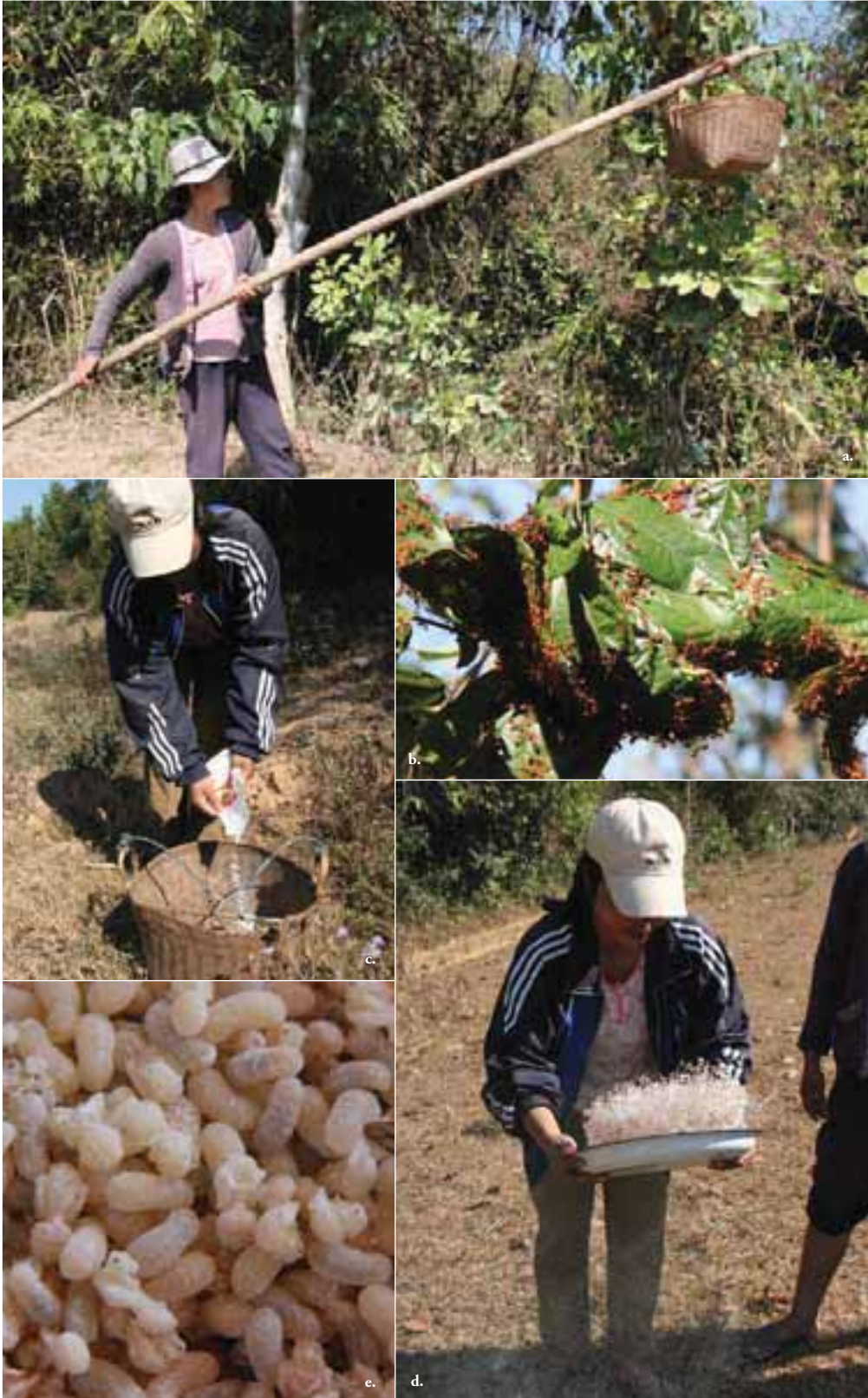


Figure 10. (a) collecting nests with a pole; (b) weaver ant nest; (c) : filling the bamboo basket with cassava starch; (d) shaking the mixture; (e) weaver ant larvae and pupae

Short-tailed cricket

(Gryllidae: *Brachytrupes portentosus* (Lichtenstein))

Lao name : *Chi nai*

General description

The short-tailed cricket is the largest field cricket known in Asia. The cricket has a large head and body and is light-brown in colour. Body length is about 5 cm, and is broadest at the prothorax where it is about 1.5 cm wide. The males bear the sound producing organs, which are files and scrapers on both sides of the fore-wings.

All stages are active at night and each individual excavates and inhabits a permanent burrow in the soil - that of an adult averaging 50 to 60 cm in depth. The burrow has an enlarged chamber in which the cricket lives and stores food. There is one generation produced each year. The eggs are laid in the burrows and, upon hatching, the young nymphs crawl away from the parent burrow, in all directions, in search of suitable places in which to start digging their own burrows. The burrows may be located in virgin land or in cultivated land, or along the borders of cultivated fields, such as corn and paddy fields. The food consists of succulent or dry vegetable matter (according to the time of year) and is carried to and stored in chambers in the burrows.

Collection method

Cricket is collected from fields by using a small spade, digging carefully into the soil at a depth of 30-50 cm. The short-tailed crickets are available in markets between September and December. During this time, it is common to also find them in some restaurants and bars in the Capital, Vientiane, as they are the most commonly consumed insect in these places.



Figure 11. (a) the cricket collector; (b) burrow of short tailed cricket; (c) both sexes short tailed crickets; (d) short tailed crickets sold at the market

Domestic house cricket (Gryllidae: *Acheta domesticus* L.)

Lao name : *Chi Lor*

General description

Domestic house crickets are typically grey or brownish, growing to 16 to 21 millimetres in length. Males and females look similar, but females have an ovipositor emerging from their rears, around 12 millimetres long. The ovipositor is brown-black and is surrounded by two appendages, which facilitates egg laying in soil. On females, the cerci are also more prominent. Males have wrinkled surfaces on the forewing.

Crickets belong to the Order Orthoptera and the species *Acheta domesticus* was introduced to Southeast Asia from temperate regions in Europe and the United States. Crickets move by walking and jumping. The wings are poorly functioning for flying, and are mainly used by the male to attract females with stridulations. The nymph and adult of each sex are identical with the exception of wings and genitalia. The total life cycle from eggs to adulthood takes around 40 to 45 days. Eggs incubate for about 10 to 15 days; nymphs development is 6 to 8 weeks; and adult longevity is about 2 months. Sexual maturity can occur after 1 to 2 weeks.

Domestic house crickets are usually bred in cement tanks, but cheaper material such as wood or plastic can also be suitable. The rearing habitat is covered by a mosquito net to keep predators out and crickets in. Smooth adhesive tape is also added at the top of the container to prevent escapes. The bedding is usually made of a layer of rice husks. Farmers have to install some hiding places in the enclosures where crickets can moult without disturbance. Papers or egg cartons made from cardboard are commonly used for this purpose.

Crickets are nearly omnivorous. Thus, they can be fed various types of feed. Usually, breeders provide the crickets with chicken feed, but they can also be fed cassava leaves, maize powder or rice bran. A few days before harvesting, the

crickets are fed with pumpkins or vegetables. In most cases, pans or bottles of water provide the crickets with drinking water. The pans are filled up with a piece of cloth to prevent the crickets from drowning.

As soon as the males stridulate, several plastic bowls containing a mixture of burned rice husks and sand are placed in the concrete breeding enclosure, to provide the crickets with a place to lay their eggs. After 12-24 hrs, the bowls are moved to another concrete tank enclosure for one week for incubation and hatching. In the egg-laying enclosure, each bowl is further filled with rice husks to maintain an even temperature and to keep out predators. The separation to new egg-laying enclosures can be repeated 1-3 times for each generation, though the numbers of crickets produced each cycle tends to decrease.

Cricket activity and development are dependent on temperatures. Thus, a slight decrease in production is observed during the coldest months of the year in Vientiane (average cold season low: 22° C).

Collection method

Although crickets can be found and collected in the wild, by far the most common source is insect farms located in the Vientiane capital and other provinces in the country. Cricket breeding enjoys considerable success among many low- and medium-income farming families. The breeding system is particularly easy to manage, requires little time and ensures quick and prolific production of crickets. Farming crickets is quite new to Lao PDR. The FAO supported the establishment of the Edible Insect Demonstration Unit for house cricket farming at the Faculty of Agriculture of the National University of Laos (NUoL) to promote cricket farming and other species.



Figure 12. (a) farmed domestic house cricket; (b) farmed domestic house cricket sold at the market

Red palm weevil

(Curculionidae: *Rhynchophorus ferrugineus* Oliver)

Lao name : *Dong Mak Prao*

General description

The palm weevil, or sago weevil, is a species of beetle that is 2 to 5 cm in length; the body is red and has a long snout. The male and female can be distinguished by the snout shape; the female has a thin and long snout without hair, while the male has a thick and short snout with short hairs at the end. The weevils usually feed on palm and sago trees (Hanboonsong and Inthakoun 2010).

Three to five days after mating, the females lay approximately 200 eggs. The eggs hatch into white legless grubs and take 25 to 30 days to reach the fully developed larval stage. The pupae take another 10 to 15 days to develop. After another 10 to 15 days, the adult weevils emerge. The total life cycle takes about six weeks and the fully grown larvae can be sold in the market when they are 30 days old (four weeks after hatching). The larvae are most often used for human food or animal feed, because the larvae produce optimal levels of energy, are easy to handle and easy to harvest.

The larval grub is considered a delicacy in much of Southeast Asia. ‘Sago Delight’ or ‘Fried Sago Worms’ are considered a specialty in Malaysia, and variations of this dish can be found in many Southeast Asian countries and Papua New Guinea, where it is also regarded as a delicacy.

Collection method

Palm weevils can be found where food plants, oil-palm, coconut and sago trees are planted. Larvae live inside the stems and can be collected by splitting open the tree stems.

Palm weevils are farmed in southern provinces of Thailand. The FAO-supported edible insects project in Lao PDR, supported the piloting of palm weevil farming at the Faculty of Agriculture at NUoL for food production purposes and facilitated the transfer of technology and know-how from Thailand to Lao PDR.



Figure 13. (a) adult red palm weevil; (b,c) palm weevil grub

Mealworm beetle (Tenebrionidae: *Tenebrio molitor* L.)

Lao: *Dong Nannok*

General description

Mealworms are the larval form of the beetle, *Tenebrio molitor*. The adult has a blackish colour. The life cycle from egg through adult takes three to six months. The egg stage lasts from five to seven days; the larval stage is about 55 to 75 days; and the adults live between 60 to 80 days. Female beetles can lay 200 to 500 eggs during their adult lives. As mealworms are rich in protein, they are bred as a feed for livestock and fish.

Pupae

In its pupae stage, the mealworm looks like a little white alien. The pupae do not require any food or moisture at this stage. About a week after they have turned into pupae, they begin to turn a darker colour. They will hibernate in this cocoon stage for up to two to three weeks before emerging as a beetle.

Beetles

The adult stage of the mealworm is a beetle. The newly emerged beetle will first appear to be a light brown-orangey colour, but will turn into a dark shade with a hard shell within a few days. Once they become adults, they are ready to breed.

It is difficult to distinguish male from female beetles. Female beetles will lay up to 500 eggs. Beetles usually die after several months.

Collection method

Mealworms are farmed commodities and not harvested from the wild. They are commonly used as feed for reptiles, fish and birds and have a high protein content, which makes them especially useful as a feed source. They are also commonly used for fishing bait. For human consumption, mealworms may be easily raised on fresh oats, whole wheat bran or grain, with sliced potato or carrots and little pieces of apple as a water source. The FAO-supported edible insects project supported the Faculty of Agriculture at NUoL in farming mealworms by using rice bran and beer-brewing by-products as feed.

Mealworms grow best in well ventilated containers, 8 to 10 inches deep, with large surface areas, and smooth sides to prevent them from escaping. Mealworms are mostly nocturnal and prefer a dark environment. The larvae can eat flour or cereals. Moisture is provided by small amounts of fruit or vegetable matter that should be replaced before it goes mouldy



Figure 14. (a) mealworm beetles; (b) larvae; (c) pupae

Current status of edible insect farming



Figure 15. (a) the edible insect demonstration unit at the Faculty of Agriculture, Nabong Campus; (b) training farmers for insect farming at the unit; (c) training school students for cricket farming at the school

The farming of edible insects is a relatively new phenomenon in Lao PDR, although insects have been eaten in the country for centuries. Traditionally, Lao people collected insects as non-wood forest products, when required, owing to their abundance in the field. However, factors such as development, commercial farming, changing land use and climate change have necessitated edible insect farming to ensure adequate quantities are readily available for consumption. Added benefits of insect farming are that it requires far less energy and space than cattle and insects have better food conversion efficiency than livestock.

Before the project started in May 2010, almost no edible insects farming was conducted in Lao PDR. Only two cricket farmers were known to exist near the Vientiane capital. With support from FAO, the Edible Insect Demonstration Unit was established in partnership with the Faculty of Agriculture, National University of Lao PDR (NUoL) and development of edible insect farming technologies appropriate for Lao conditions were demonstrated, starting in December 2010.

Four edible insect species were given priority attention at the Demonstration Unit: house cricket (*Acheta domesticus*); mealworm (*Tenebrio molitor*); palm weevil (*Rhynchophorus ferrugineus*); and weaver ant (*Oecophylla smaragdina*). Low-cost production methods for edible insect farming were tested and optimized. Subsequently, NUoL students worked with the project to test various kinds of local vegetables and by-products from brewers as feed for the insects. After appropriate insect farming technologies suitable for Lao conditions were determined, training courses for edible insect farming were conducted. Edible insect farming technologies were transferred to several farmers and extension officers through hands-on training courses with four farmed insects at the Edible Insects Demonstration Unit. Edible insects communication materials were also produced, including an Edible Insect Breeding

Manual, video CDs outlining step-by-step demonstration of farming for four edible insect species (cricket, mealworm, palm weevil and weaver ant), and edible insect cooking recipes and video CDs demonstrating how to cook insects.

To promote edible insect awareness and consumption for the young generation, the project supported the set up of a small-scale cricket farm at the School for Gifted and Ethnic Students, NUoL, in Vientiane. Students were first trained at the Edible Insect Demonstration Unit in how to farm crickets and then applied the acquired knowledge in developing a cricket farm at their school.

Since the completion of the FAO-supported project, the Edible Insects Demonstration Unit has been maintained by the university, and is regularly used for teaching and training of students and farmer groups on insect farming. In addition, the Demonstration Unit is also used as a learning center on edible insect farming for the general public.

Cricket farming in Lao PDR

Farming crickets is quite new to Lao PDR. The cricket farming technology was transferred and distributed to Laos farmers by several means such as the Thai media, Lao students who studied at Khon Kaen University, Thai relatives who live along border provinces and through the FAO-supported “*Sustainable insect farming and harvesting for better nutrition, improved food security, and household income generation*” project. The project has created momentum to expand the establishment of cricket farming in Lao to other provinces from initial introduction around Vientiane.

Two cricket species, domestic house cricket (*Acheta domesticus*) and common cricket (*Gryllus bimaculatus*) are farmed. Sometimes these two cricket species are farmed in the same farms. However, the house cricket is slightly more popular than the common cricket. It is estimated that there are around 27 cricket farmers who can produce around 19 000 kg per year of crickets (Hanboonsong and Sriratana 2013). The cricket farm capacity can produce about 20 kg of crickets/

one harvesting cycle of 45 days for small farms and more than 100 kg/ one harvesting cycle of 45 days for bigger farms. According to the field survey from Hanboonsong and Sriratana, in 2013, the largest production volume of farmed crickets is at the Vientiane capital and in Vientiane province. Cricket farms are mainly small scale with low investment. Most farms use rounded concrete tanks as breeding containers, while others use a square wooden boxes. The cricket production is relatively low, with an average of 130 kg/year from the rounded concrete tanks and 1 400 kg/year from the square wooden box containers.

Cricket farming requires varying degrees of labour input throughout the rearing cycle. One person-day must be devoted to the transfer of the egg containers from the main enclosures to the empty egg-laying enclosures and daily feeding typically requires one hour of work for one person. Capital investment is approximately US\$760 for a breeding area of 60 square metres containing 61 concrete enclosures. Annual costs for food and other consumables at a typical cricket farm are approximately US\$1 100 and revenues from the sale of the insects and their eggs can reach US\$2 350 for a net income of US\$1 250 or roughly US\$21/m²/year.

Taking into account the ease of setting up a cricket farm and low running costs, it is no wonder that cricket breeding has become popular in Lao PDR. Moreover, there is potential for exporting excess supply from Vientiane. The conversion of excess crickets into food additives (insect flour or paste) could also be explored.

In this context, it is important to consider the development of insect farming as a way to avoid the unsustainable use of wild insects as a food resource. The domestication of insects can allow a continuous supply of protein representing a significant asset, especially when food supplies are running low.

However, it is important to identify the factors that encourage villagers to collect wild insects. It is a misconception to believe that Lao people collect and eat insects because they lack other food alternatives.



Figure 16.

(a) rounded concrete tanks for breeding;

(b) cricket farmer;

(c) square wooden box containers;

(d) cricket farmer

Consumption

Lao people have always consumed insects, similar to their contemporaries in Thailand and other Southeast Asian countries. Insect consumption in Lao PDR is highly cultural and people consume insects as snacks or sometimes as a main food item. Different stages of the insect's life cycle are eaten, but consumption mainly targets the adult stage.

Insects offer a good source of nutrients with high protein content, as well as many vital vitamins and minerals that are comparable to those provided by more conventional animal sources. It is also recognized that some insects can be raised as a human food source in ways similar to conventional livestock (cattle, pigs and poultry), or shrimps. Compared to conventional livestock, the food conversion efficiency (an animal's efficiency in converting feed mass into increased body mass) is much higher in insects, making them a more 'environmentally friendly' food source. Insects contribute to the Lao diet and insect consumption is well accepted. In some regions, insects are reported as an essential part of the diet, especially during times of food shortage. Only a small part of the population buys insects, whereas most people harvest insects from their natural habitats.

Most insects (bamboo worms, cicada nymphs and adults, dung beetles, scarab beetles and green weevils) are fried and eaten with other food during meals. Only one insect, the stink bug, is known to be eaten raw with sticky rice. Weaver ant brood is mixed with meat and vegetables and steamed in banana leaves (like dragonfly nymphs) or are consumed in omelettes and soups. Hornet larvae are usually steamed. For some insects, mostly beetles belonging to the Family Scarabaeidae, the wings are removed before consumption to avoid digestion problems.

Even if most of the insects are seasonally available, no preservation for later consumption has been observed. In some African countries, the insects are dried in the sun to be consumed later (Van Huis 2003). According to Spinazze (2011), decisions on conserving insects or not depend on the species. Most insect collectors do not preserve any insects for future consumption.

Quaglietta (2011) reported that some mothers in Lao PDR start to give insects to their children at the age of ten months and no risks appear to be associated with this practice. Indeed, even if more attention should be directed toward assessing the risks, this result confirms that insects intentionally harvested for human consumption do not pose significant health problems (DeFoliart 1999).

Children generally prefer the softest insects. In Luangnamtha, children prefer bamboo worms and bee larvae, while in Savannakhet and Attapeu they prefer weaver ant eggs. The reasons for these preferences are ease of chewing and taste.

In general, the most common insects eaten by children under two years of age are grasshoppers, large and small crickets, bamboo worms, weaver ant eggs and bee larvae.

Mothers are willing to increase the amount of insects in the diets of their children as they are aware of their health value. The only impediment for increased use seems to be the availability of insects. This is encouraging, in the context of insect consumption, because of the opportunity to expand farming practices. However, more studies need to be carried out on the risks of excessive consumption of edible insects. Yhoun-aree (2010) reported that excessive consumption could fill the stomach with chitin and chitosan, protein and fat, which carries the risk of urinary tract stone formation and development of chronic degenerative diseases.

Nutritional values of edible insects

Edible insects provide essential macronutrients, such as energy, protein, fat and carbohydrates that can help to improve Lao diets (Table 2). Carbohydrates and fat are the main food sources that provide energy for human bodies to carry out daily tasks. Moreover, carbohydrates help to keep the digestive tract healthy. They slow digestion and absorption of nutrients in meals, and help to prevent obesity.

Nutritional values of insects vary considerably by species and can be explained by external factors such as climate, diet and habitat of the insects. They also depend on how the insects are prepared and cooked prior to consumption.



Figure 17.
cooking insects



Table 2. Nutrient contents of commonly eaten insects in Lao PDR in comparison to meat alternatives per 100 grams of blanched insect

Insect/animal	Energy (kcal)	Protein (g)	Carbohydrate (g)	Fat (g)	Calcium (mg)	Iron (mg)
House cricket	134	12.9	8.1	5.5	76	9.5
Grasshopper	96	14.3	2.2	3.3	27.5	3
Silkworm pupae	127	12.2	4	7	42	1.8
Scarab beetle	98	13.4	7.9	1.4	23	6.4
Giant water bug	182	19.8	7.1	8.3	44	13.6
Beef (boiled)	218	27.6	0	12	11.4	3.5
Fish (boiled)	130	19.2	0	5.9	108.5	0.6
Eggs (boiled)	143	12.5	0.3	10.3	57	2.5

Adapted from Yhoung-Aree and Viwantpanich (2005).

Processing and safety aspects

Fried insects available at the markets in Lao PDR are mostly safe for consumption. However, such 'ready-to-eat' products always involve some food safety risks because safety depends on preparation and storage methods applied by producers and vendors. Moreover, when food items have been cooked some time prior to consumption, there can be increased risk of contamination, particularly if the food is handled or stored improperly.

Lao people are very sensitive about eating clean and fresh food Barennes (2010). There is always concern about eating vegetables that could have been in contact with pesticides. Due to the wide diversity and origin of insects, especially those harvested from the wild, in general it is difficult to conclude the level of safety of edible insect consumption. On the other hand, insect farming allows for strict control on their environment, feed and water, hence greatly reducing the risk of contamination with harmful bacteria or chemicals.

Regarding food safety issues, edible insects have yet to be studied fully by scientists. However, an embryonic small-scale examination of the

microbiological hygiene of edible insects and processing methods was conducted by FAO and the Faculty of Science at NUoL as described below, as part of the FAO-supported project.

Microbiological experiments were performed to assess the safety of edible insect consumption, focusing on the effects of boiling and frying them. The effectiveness of several storage methods was also analysed microbiologically.

Microbiological quality was assessed using three quantitative microbiological indicators of hygiene in the insects before and after certain treatments. Total Viable Count (TVC) was used to assess the overall hygiene of the samples by indicating the total amount of mesophilic aerobic bacteria in the food. The levels of Enterobacteriaceae (coliform bacteria) and spore-forming bacteria were also assessed for specific food treatments.

It was revealed that fresh crickets had a higher initial contamination than processed crickets. But, after the crickets had been both boiled and fried, the Enterobacteriaceae and spore-forming bacteria were totally inactivated and were no longer a health hazard. In samples that were only

boiled or only fried, spore-forming bacteria were not totally inactivated. This is most likely because of the heat-resistant characteristics of the spores, formed by these bacteria, which can survive these processes. The obtained levels of spore-forming bacteria (up to log 3.0 cfu/g in stir-fried house crickets) did not exceed unsafe levels; unsafe levels are $> \log 5$ cfu/g. However, these levels could become a hazard due to their ability to continue growing under certain conditions (for example being kept at high temperatures in sunlight while on display in the market). Boiling is shown to be a more efficient processing method for inactivating micro-organisms in house crickets than frying.

There was only a small difference between the effects on the microbiological content of short-tailed crickets after boiling times of 5 minutes and 10 minutes. It is worth mentioning that in local traditional cooking practices the intestines of large crickets like short-tailed crickets are usually removed before frying.

The study confirmed that adequate processing and storage of edible insects are essential in the context of microbiological safety, similar to meat and fish products. Boiling or frying for at least five minutes is a good preparation method because the initial microbiological contamination is reduced to safe levels for human consumption. Cold storage (refrigerated or frozen) of insects is a good method for storing insects safely; if such facilities are not available (many households in Lao PDR cannot afford them) drying (sun-drying) or acidification (boiling in vinegar) are other possible storage solutions. However, these processes need to undergo further research, not only regarding safety but also quality, consumer acceptance and financial feasibility. The major concern about edible insects is heat-resistant spores created by bacteria that could cause health hazards.

Recommendations for safe preparation and storage of edible insects

Considering the microbiological safety of a food product, hygiene is very important. Proper handling, preparation and storage of food

products can be controlled by both consumers and producers and are vital with regard to the microbiological safety of the product.

As scientific studies do not generally acknowledge insects as food products, very little information on safe handling methods has been published. Thus, it is important to start compiling information on critical measures in the preparation and storage of insects as food.

At this stage, some general advice on the handling, preparation and storage of edible insects for restaurant owners and domestic consumers can be given.

First and foremost, it is important to adhere to common sense. If a food product smells or appears bad, it should be discarded.

In general:

- Wash insects before preparation for eating
- Refrigerate insects and keep them cool until ready for use.
 - In a refrigerator ($\pm 4-7$ °C)
 - In a freezer (± -18 °C)
- Preferably boil or steam insects shortly before cool storage
- Cook insects properly before consumption:
 - Boil for at least five minutes
 - Deep-fry or fry for at least five minutes
- Consume prepared insects immediately. If this is not possible, keep the insects in cold storage.

To date there has been insufficient research on other forms of safe preservation.

Considering the 'ready to eat' insects sold at the market, advice is comparable to the *Basic steps to improve safety of street vended food* by the World Health Organization (2010).

Consumers need more information on safe consumption levels of edible insects. While it has been reported that excessive eating of edible insects could contribute to degenerative disease, more research on this issue is needed.

Marketing

Currently, insects are expensive in Lao PDR and low-income earners cannot afford to buy them. Poor people consume insects after collecting them directly, rather than buying them in markets. When insects are purchased by more wealthy individuals, the two most important criteria for buyers are freshness and the perception of insects as a natural food (Ninon 2010).

A small proportion of the total insect supply is offered for sale, either on the sides of major roads to passing motorists or in nearby open-air urban markets. An even smaller proportion is exported to other provinces or to Vientiane.

Barenes (2010) surveyed insect sellers. According to vendors, the best time to sell is in the afternoon or early morning with no particular day of the week having a higher number of sales than any other. Vendors' entire stocks are generally sold within one day, they believe they could probably sell more if they had more to sell. A large proportion of sellers (88 percent) noted that the rainy season is a difficult time to sell insects. This is most likely because it is easier to collect insects during this season, so many people collect their own rather than buy them. Most insects (64 percent) are sold live, whereas less than a fifth are sold already pre-cooked.

An assessment focusing on retail outlets in Vientiane revealed a diverse supply chain for insects with many actors working directly and indirectly to bring insects to the final consumers (Ninon 2010). Insect dealers (intermediaries) require a stable, yet diverse, and high-quality supply of insects throughout the year.

Fixed agreements are rare between suppliers, dealers and/or retailers. Orders are typically placed by phone, either initiated by a supplier (for example, if a supplier suddenly receives a shipment from outer provinces) or a retailer/customer when

demand arises. Therefore, the network of contacts (with mobile phone numbers) is extremely important for all actors in the supply chain. Wholesale supplies are sometimes available for sale at a set hour at Khuadin Market, but this is not always the case. The vast majority of all edible insect purchases are made by final consumers at open-air markets, where the average purchase is 150 to 200 grams.

The price of insects in Lao PDR varies greatly by species, life stage, season and location. In very general terms, the lower-priced insects are house crickets and certain cicada species, while the most valuable insects tend to be larvae of weaver ants or wasps. The most profitable insects for sellers, according to vendors surveyed by Barenes (2010), are weaver ant eggs, bamboo worms and short-tailed crickets.

Some insects are imported, such as silkworms from Viet Nam and crickets from Thailand. In both cases, this is because the imported insects are less costly – despite added transportation costs – than those collected or produced in Lao PDR. One retailer from Viet Nam, now living in Lao PDR and selling insects at the Khuadin Market, imports silkworms from Hanoi in large quantities (several 50-kilogram boxes at a time). Despite the additional transport costs – silkworms are hauled by bus from Hanoi – the vendor's cost per kilogram is still significantly lower than for those purchased from the town of Vang Vient in Vientiane District (17 600 kip/kilogram for the imported insects as against 28 000 kip/kilogram for the domestic silkworms).

The best outlets to find insects in Vientiane are mostly Dong Makhai, Khua Khua, Nong Niaw and Khuadin markets, but Salakham, Tong Khan Kham and Dong Dok markets also offer good selections.

Obtaining accurate perspectives of the structures and functioning of insect markets in Vientiane is not easy. Some breeders and sellers claim to desire higher quantities of insects to sell because demand is perceived to be increasing. Others are comfortable with current arrangements and practices. Breeders tend to inject uncertainty into

the markets by not providing consistent supplies of insects and sometimes attempting to exert price pressure. Generally, the market situation for insects in Lao PDR typifies an immature and fluid market, with frequently shifting players and strategies.

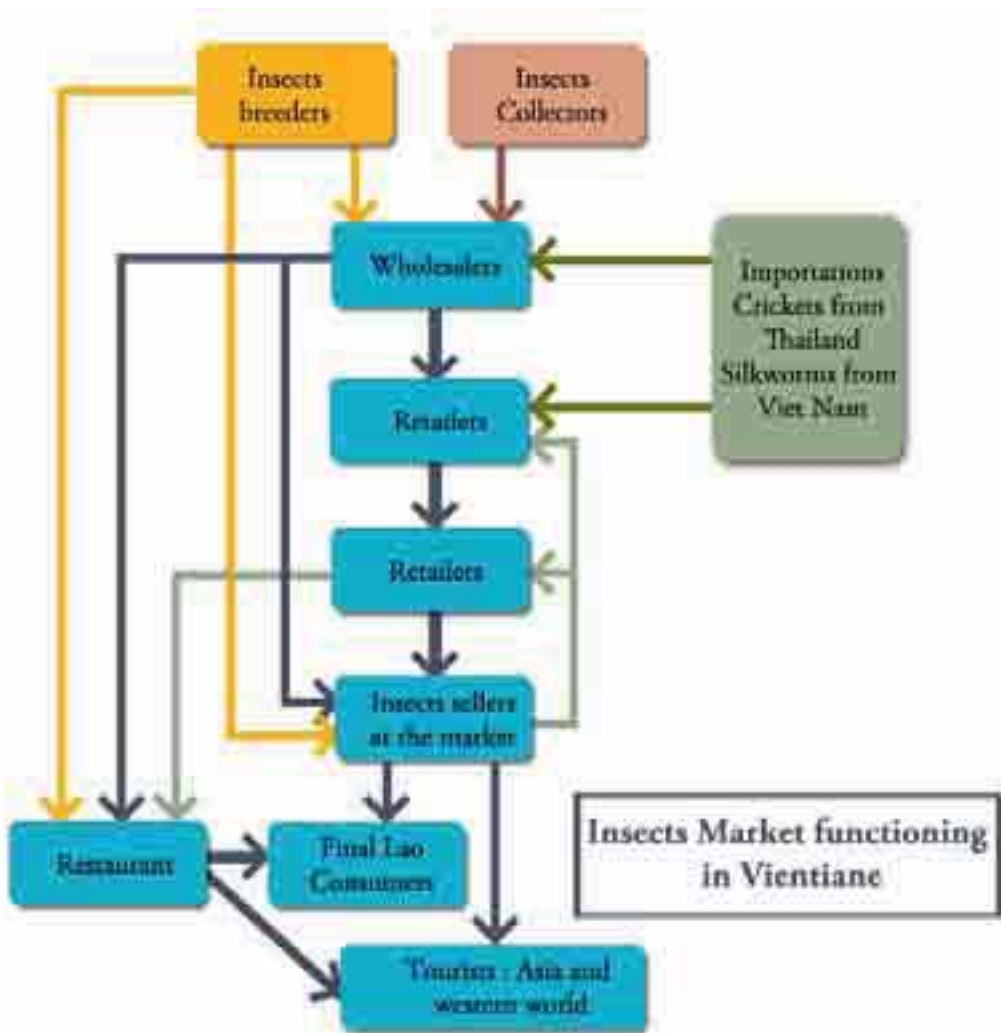


Figure 18. Flow Chart of edible insect market chain in Vientiane

Campaigning for edible insect consumption and farming

Insects provide a number of important nutritional benefits (protein, calcium, amino acids, etc.) which are essential to proper human development and which may not be available from other food sources, especially amongst the most food insecure households in Lao PDR. Several activities of the FAO-supported project were conducted to promote the ongoing consumption of edible insects as a sustainable way to enhance food security and nutrition. Emphasis was placed on both insects from wild harvest and insect farming, recognizing both as providing opportunities to increase rural incomes and livelihoods, and enhance food security and nutrition.

In partnership with the Faculty of Agriculture, National University of Laos (NUoL), FAO supported the establishment of an Edible Insect Demonstration Unit at Nabong Campus where standard protocols and techniques for the insect farming of four target species – house crickets, mealworms, palm weevils and weaver ants were developed.

Training courses on new edible insect husbandry techniques are conducted regularly for participants to enhance the management practices of insect farmers and boost incomes. The breeding techniques, insect marketing and the nutritional values of the four target species continue to be taught. Training on insect breeding for extension workers nationwide has also been conducted to more effectively disseminate information to help farmers start their own insect farms in the provinces.

Small-scale cricket farms were established at the School for Gifted and Ethnic Students, NUoL, in Vientiane, to promote food security and

increase awareness of nutrition related to edible insects among students. Various activities were conducted with students including cricket farming, education on insect biology, basic nutrition, drawing competitions and exhibits related to edible insects and livelihoods, and training on cooking cricket dishes after harvesting of the crickets. Many students at this school come from poor remote areas across all of Lao PDR, representing many different ethnic groups. As such, it is anticipated they will take the knowledge they have acquired on edible insects and nutrition back to their home towns and farms.

Various public events have been organized to promote the cultural and nutritional significance of Lao insects. In August 2010, FAO organized the first insect cooking competition called “Saep Lai Lai” with the objective of paying tribute to traditional Lao cuisine and promoting the continued use of edible insects in Lao diets. Fifteen major restaurants from Vientiane competed to prepare their best insect-themed dishes in various styles. The first prize was awarded to the Sticky Fingers Restaurant for their insect tacos submission.

Saep Ei Lee (Lao language phrase meaning “very delicious”) was organized at the School for Gifted and Ethnic Students in 2011 to promote cricket farming, harvesting and cooking among students and the general public.

Seminars and exhibitions on farmed edible insects and cooked dishes from edible insects were regularly organized for the public to promote awareness and appreciation of edible insect consumption.



Figure 19. Edible insect dishes: (a) insects sushi; (b) steamed fishes amok with crickets; (c) grasshoppers fried with lemon grasses; (d) fried vegetables with bamboo worms; (e) noodle with silk worm pupae



Figure 20. (a) participating chef; (b) cooking for the insect food contest; (c) winning insect tacos; (d) the steamed mok honey bee larvae winning for the runner up; (e) insect dishes at the contest

Case studies from cricket farmers

Case 1: Mr Kongkeo, Don Deng village, Chanthabouly, Vientiane Capital

Mr Kongkeo grows and sells vegetables for retail in the market. After participating in the training on insect farming, he started a cricket farm with eight tanks as depicted in the photographs below.

Mr Kongkeo's crickets consume chicken feed and concentrates twice a day; water is supplied via moist tissue spread over a plate. The building where the crickets are housed and the tanks in

which they live are made from cement. Pest attacks (mainly ants) are thwarted by a small channel surrounding the building which is periodically refilled with waste oil. Blue netting prevents incursions by other insects. Presently, Mr Kongkeo produces approximately 26 kilograms of crickets every 45 days, which he sells at the market for 50 000 kip per kilogram. Thus, Mr Kongkeo has about 1 300 000 kip revenue from insect farming every two months. Owing to this success, he plans to expand production in due course.



Figure 21. (a) Cricket-raising tanks; (b) damp tissue on a large plate for hydration; (c) waste oil in the channel prevents ant attacks; (d) blue netting provides protection against other insects

Case 2: Mrs Baithong, Don Deng village, Chanthabouly, Vientiane Capital

Mrs Baithong is a retired government officer. Fortuitously, she participated in a project training workshop and subsequently decided to start a cricket farm with five tanks.

Mrs Baithong also uses chicken feed to feed her crickets, supplemented with cassava leaf and cabbage twice a day, and damp tissue on a plate as a water source. Mrs Baithong prevents

predatory insect incursions by using the same methods as Mr Kongkeo.

She produces approximately 5 kilograms of crickets per tank, or 25 kilograms total, every two months. She cooks and sells them in the village market or sells them uncooked at 50 000 kip per kilogram. Mrs Baithong's average income is about 1 500 000 kip every two months. The extra money is very useful for her and her family.



Figure 22. (a) Cassava leaves are used as concentrate feed; (b) tissue soaked in oil lines bins for protection against predators

Case 3: Mrs Chansamai Northlintha, NongTeng Tai village, Sikoth District, Vientiane Capital

Mrs Chansamai is a housewife, but she also earns income from cricket farming. She does not raise crickets in tanks, but uses 13 wooden crates (2.5 x 1.2 metres). She raises house crickets and common crickets.

Chicken feed is the main form of nutrition provided to the crickets, supplemented with banana leaf, cassava leaf, pumpkin and ripe papaya prior to harvesting to make the crickets more tasty and aromatic. Mrs Chansamai cuts plastic bottles in half and stuffs them with moist tissue to provide hydration. Predators are inhibited using the same techniques as the the farmers highlighted in the previous case studies.

Mrs Chansamai can deliver about 100 to 120 kilograms of crickets per month to the market and restaurants, which she sells at 50 000 kip per kilogram. On average, she earns 5 000 000 kip per month, which is very high income compared with other traditional farmers. Moreover, she also has customers from other provinces (such as Xayabory Province) who buy crickets, cricket eggs and study from her how to farm insects.

The cases show that the farmers use different materials for cricket farming. Most use chicken feed as the main source of nourishment for crickets, but they are creative in identifying supplemental feeds depending on local availability.

According to the farmers, cricket farming is easy and anyone can do it. However, they observed that after three or four harvests the crickets become very weak, many die and production is very low. Some farmers have addressed the problem by changing to new varieties or cross-breeding with other farmers' crickets.

Constraints

Marketing is considered to be a significant constraint by some farmers because there is a perception in Lao PDR that insects are only snack foods and therefore consumer demand remains relatively limited.

Farming of edible insects is not officially endorsed by government policy. Moreover, markets are not stable, input costs are high and there is little available information on farming techniques, diseases, pests, feed formulations or marketing. The farmers generally only learn through trial and error and sharing of information with other farmers. For some farmers, finding the funds to establish insects farms is difficult.



Figure 23. (a) Wooden crates are used to house the crickets; (b) ripe papaya is also used as a feed source

Farmers have only weak linkages with extension workers and researchers at best on matters of insect farming. Farmers normally have no one to consult if they experience problems.

The stock-taking survey revealed that to date the training on insect farming has had mixed results, but there has been a generally positive trend in encouraging local people to become interested in edible insect farming. Several farms have been established and are proving to be viable enterprises. Small farms can generate about 20 kilograms of insects every 45 days and for larger farms more than 100 kilograms in the same time period. The farmers involved have been highly innovative in adapting techniques from the training for feed formulation and protection of their insects from predators. Regarding marketing chains, group

production has the best potential to maintain a steady supply of insects to markets and thus reduce price fluctuations.

Expanding the consumer base is a significant challenge. Currently, edible insects are most often perceived by urban dwellers only as snack foods to be eaten in bars and restaurants. There are no established processing centres or factory facilities to expand the production of more refined value-added insect products. Presently, the government has only limited involvement in promoting edible insect farms. Farmers lack important information about raising insects and few sources of extension assistance. At the moment, insect farming is developing almost exclusively through the drive, determination and initiative of the farmers themselves.

Conclusion

People have been eating insects in Lao PDR since time immemorial and they are now being increasingly recognized within the country for the health and environmental benefits they can generate, quite apart from their palatability and the income that they can supply to improve livelihoods. Of the plethora of species available, weaver ant eggs, house crickets, short-tailed crickets, grasshoppers and cicadas are the most popular in local markets.

Supply and consumption of edible insects continues to be dominated by the collection of insects from the wild by villagers in the provinces. However, insect-breeding farms are expanding in the outskirts of Vientiane – largely for house crickets – with considerable support from NUoL and FAO. The relatively embryonic state of insect

farming in the country and the need for an additional food supply to bolster food security and mitigate malnutrition rates is recognized by the Lao Government, which is taking steps to promote the edible insect sector.

There are valuable lessons for Lao PDR to be learned from the thriving insect-eating and production sector in neighbouring Thailand with regard to developing sustainable consumption, collection, farming and marketing activities. In turn, Lao PDR has much to offer the rest of the world in terms of traditional insect collection, management practices and local consumption habits. Such experience could prove valuable for further promotion of entomophagy in Lao PDR and in other countries.



明凌胡
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JiaJia Restaurant

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A). Crickets



Cricket cake

Ingredients

- 1 kg crickets
- 3 cups crushed lemongrass
- 1 tablespoon crushed bergamot leaves
- 1 cup thinly sliced bergamot leaves
- 3 garlic cloves
- 3 teaspoons salt
- 300 g corn flour
- ¼ cup tapioca flour
- 1 tablespoon chicken stock powder
- 2 tablespoons oyster sauce
- 5 chicken eggs
- 650 ml water
- 100 g red curry paste
- 1 cup chopped (long) green bean
- Cooking oil

Directions

1. Wash the crickets, then boil for 10 min.
2. Pound the boiled crickets thoroughly and mix them with all other ingredients except the corn flour and water.
3. Mix corn flour and water together until it is a smooth paste, then combine with the other ingredients mixed in step 2.
4. Heat oil in a pan until medium hot, then fry the mixture until golden and fragrant.
5. Serve.

Pan-fried crickets with herbs



Ingredients

- 1 kg boiled crickets
- 3 cups sliced lemongrass
- 3 cups sliced bergamot leaves
- 2 tablespoons sliced galangal
- 1 cup sliced Pandanus leaves
- 15 garlic cloves
- 2 teaspoons chicken stock powder
- 2 teaspoons salt
- 2 litres cooking oil

Directions

1. Wash the crickets; then boil and allow to cool and dry for 10 minutes.
2. Heat cooking oil in a pan, then fry the crickets and add the sliced lemongrass, sliced galangal, garlic and sliced Pandanus leaves.
3. Cook until crackling starts.
4. Combine the ingredients with the bergamot leaves, fry together for a few minutes, then remove from heat and cover.
5. Add salt and chicken stock powder and serve.



Jaew crickets

Ingredients

- 1 kg crickets
- 3 cups grilled shallots
- 30 grilled chillies
- 15 grilled spring onions
- 50 grilled garlic cloves
- 3 teaspoons salt

Directions

1. Wash the crickets, boil for 10 min and allow to dry.
2. Put the crickets into a pan and stir-fry in oil until crispy.
3. Pound the garlic, chillies, spring onions and shallots together, then combine the mixture with the fried crickets. Mix thoroughly again.
4. Serve with fresh vegetables.

Cricket chilli paste

Ingredients

- 13 g kaffir lime leaves (veins removed)
- 35 g lemongrass
- 35 g galangal
- 15 g dried fried onions
- 15 g dried fried garlic
- 15 g chilli powder
- 3 teaspoons brown sugar
- 25 g cricket powder
- 1 teaspoon salt
- ½ teaspoon lemon juice
- MSG (optional)

Directions

1. Fry the lemongrass in soybean oil and remove when brown.
2. Fry the galangal until it is dry. Remove from the oil.
3. Repeat for the kaffir leaves.
4. Pound the fried lemongrass, galangal and kaffir leaves using a pestle and mortar.
5. Add onions, garlic, chilli powder, a pinch of MSG, salt, brown sugar, lemon juice and cricket powder.
6. Pound until a dry paste is obtained and fry again.

Cricket cookies



Ingredients

- 300 g crickets
- 2 eggs
- 10 garlic cloves
- 5 kaffir lime leaves
- 1 teaspoons salt
- Cooking oil

Directions

1. Wash and clean crickets, then grind in a blender.
2. Mix eggs, sliced garlic, sliced kaffir lime leaves, salt and the ground crickets in a bowl.
3. Fry small cookie-shaped portions in oil for 11 minutes.
4. Allow to cool and serve.

Gang om crickets



Ingredients

- 100 g boiled crickets
- 50 g pumpkin
- 50 g luffa
- 2 tablespoons diced shallots
- 5 kaffir lime leaves
- 3 sliced spring onions
- 10 chillies
- 3 tablespoons fermented fish sauce
- 2 lemongrass stems
- 3 teaspoons fried and ground sticky rice grains
- 1 galangal bulb
- 1 tablespoon sweet basil leaves
- 5 tablespoons chopped coriander
- 1 teaspoon sugar
- 1 teaspoon salt
- 1 tablespoon fish sauce

Directions

1. Boil the crickets until cooked.
2. Add lemongrass, galangal and chillies to boiling water followed by the pumpkin and luffa until cooked.
3. Add shallots, season with salt, sugar, fish sauce and fermented fish sauce.
4. Add the mixture of fried and ground sticky rice grains and water followed by cooked crickets; stir all ingredients well.
5. Add coriander, sweet basil, spring onion and kaffir lime leaves; stir all ingredients well.
6. Serve with steamed rice.



Kao piak chi lor (cricket noodles)

Making insect noodles (upper left: insect powder, upper right: mixing the powder with the dough, lower left: shaping the noodles, lower right: cooked insect noodles). Courtesy H. Klunder

Ingredients

- 20 g tapioca flour
- 200 g rice flour
- 2 eggs
- 50 g cricket powder
- 2 teaspoons salt
- 2 teaspoons baking powder
- Boiling water

Directions

1. Combine the two flours and baking powder with the raw eggs, then add boiling water while continuously stirring, until a lumpy dough is formed. (Tapioca flour is added in case the dough becomes too sticky, which should be prevented.)
2. Knead for a few minutes.
3. Add cricket powder and salt after obtaining the dough once it has cooled.
4. Add more tapioca flour to improve the binding quality of the noodles.
5. Feed the dough into a pasta-making machine to obtain the noodles.

B) Weaver ants

Weaver ant egg omelette



Ingredients

- 2 tablespoons weaver ant eggs
- 2 chicken eggs
- 1 tablespoon peeled shallot bulbs
- 2 spring onions
- 1 tablespoon diced onion
- 1 tablespoon diced tomato
- ¼ teaspoon sugar
- ¼ teaspoon salt
- 1 teaspoon fish sauce

Directions

1. Crack the eggs in a bowl.
2. Add weaver ant eggs, shallot bulbs, tomato, salt, sugar, fish sauce and spring onion.
3. Mix all ingredients together.
4. Heat oil in a pan, add the mixture and prepare until cooked.

Mok weaver ant eggs



Ingredients

- 2 tablespoons weaver ant eggs
- 1 chicken eggs
- 1 tablespoon chopped onion
- 1 tablespoon chopped chillies
- 2 sliced scallions
- ¼ teaspoon salt
- 1 teaspoon fish sauce
- 1 crushed lemongrass stem

Directions

1. Whisk the eggs with a fork in a bowl, mix with all ingredients and stir-fry over medium heat for 10 minutes.
2. Spread the mixture on the banana leaves and wrap tight.
3. Steam the preparation for about 20 minutes on low heat.
4. Serve with vegetables.

C).Mealworm

Mealworm cake



Ingredients

- 60 g mealworms
- 120 g tapioca flour
- 1 tablespoon curry paste
- 2 sliced spring onions
- 5 sliced kaffir lime leaves
- 1 teaspoon sugar
- 1 tablespoon fish sauce

Directions

1. Cook the mealworms in boiling water and purée in a blender.
2. Mix tempura powder and water at a 2:1 ratio and add curry paste to the mixture.
3. Mix the puréed mealworms, sliced spring onion and kaffir lime leaves, sugar and fish sauce together.
4. Heat oil in a pan, add 1 tablespoon of the mixture, smooth and fry until cooked.

Banana worm bread

Ingredients

- ½ cup shortening (vegetable oil)
- ¾ cup sugar
- 2 mashed bananas
- 2 cups flour
- 1 teaspoon baking soda
- 1 teaspoon salt
- ½ cup chopped nuts
- 2 eggs
- ¼ cup dry roasted mealworms

Directions

1. Mix all ingredients together.
2. Bake in greased loaf pan at 180° C for about 1 hour.
3. Slice and serve.

D).Palm weevil

Fried palm weevils and basil



Ingredients

- 100 g palm weevil larvae
- 50 ml coconut milk
- 50 g basil leaves
- 5 peeled garlic cloves
- 8 chopped chillies
- ½ an onion
- 1 teaspoon sugar
- 1 teaspoon salt
- ½ tablespoon oyster sauce
- ½ tablespoon soy sauce

Directions

1. Soak palm weevil larvae in coconut milk for 1 hour.
2. Fry palm weevil larvae and basil in hot oil then remove from the pan.
3. Fry garlic in hot oil, add palm weevil larvae, sliced chillies and onion.
4. Season with oyster sauce, sugar and soy sauce.
5. Add fried basil.

E).Silk worm

Silk worm nam deuang



Ingredients

- 50 g rice flour
- 2 eggs
- 100 g silkworms pupae
- 1 cup bean sprouts
- 2 tablespoons chopped spring onion
- 2 tablespoons chopped red onion
- 1 tablespoon chopped garlic
- 1 teaspoon pepper
- ½ tablespoon salt
- Vegetable oil

Directions

1. Beat the eggs in the flour and pour the mixture into a cup.
2. Chop the silkworm pupae into small pieces.
3. Wash the bean sprouts.
4. Fry the red onion.
5. Wash the spring onions and cut into small sections.
6. Heat the oil in a frying pan. Add the garlic and cook until soft and fragrant. Add the chopped silkworm pupae, bean sprouts, spring onion and salt. Wait until all the ingredients have blended together. Then remove the ingredients and leave them aside.
7. Reheat the oil in the frying pan and pour in the egg-flour mixture.
8. Put the ingredients prepared in step 1 and the red onion onto the prepared base in the middle of the frying pan and fry until fragrant.

F).Grasshopper

Pan-roasted grasshopper



Ingredients

- ½ kg grasshoppers
- 1 lemon
- 2 crushed garlic cloves
- Salt

Directions

1. Remove the legs, heads, wings and guts of the grasshoppers.
2. Pan-roast the bodies over a high heat for about 10 minutes or until they turn red.
3. Add the lemon juice, salt and garlic and serve immediately.

G).Bee larvae

Marinated bee larvae

Ingredients

- 1 cup bee larvae
- 1 Sliced onions
- 5 kaffir lime leaves
- 1 cup coconut milk
- 1 teaspoon pepper

Directions

1. Marinate the bee larvae, the sliced onions and the citrus leaves in coconut milk, adding some pepper.
2. Wrap in pieces of linen and steam.
3. Serve as a topping for rice.

H).Bamboo worm

Bamboo worm stew

Ingredients

- 1 cup dried bamboo worms
- 1 chopped onion
- 2 green peppers
- 6 diced tomatoes
- 1 tablespoon curry powder
- ½ litre of water

Directions

1. Wash the worms and boil them for 30 minutes.
2. Drain, then add the rest of the ingredients and simmer for about 1 hour.

I).Wasps larvae

Steaming wasps



Ingredients

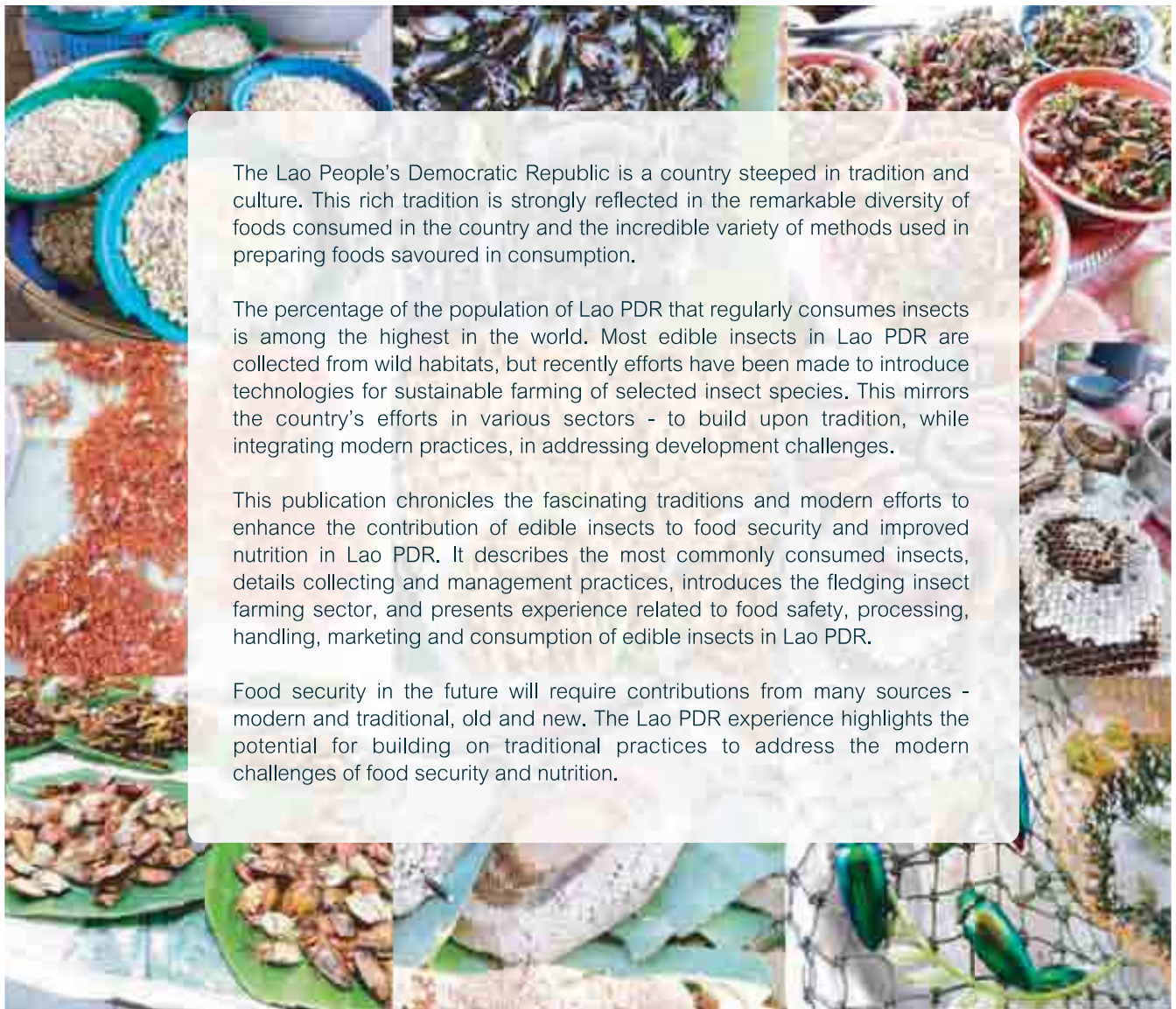
- wasps larvae

Directions

1. Simply steam the wasps in a steamer (can steam the larvae together with the entire nest or alone). Most Lao people prefer to steam the entire nest and eat only wasp larvae after steaming.



EDIBLE INSECTS IN LAO PDR: BUILDING ON TRADITION TO ENHANCE FOOD SECURITY



The Lao People's Democratic Republic is a country steeped in tradition and culture. This rich tradition is strongly reflected in the remarkable diversity of foods consumed in the country and the incredible variety of methods used in preparing foods savoured in consumption.

The percentage of the population of Lao PDR that regularly consumes insects is among the highest in the world. Most edible insects in Lao PDR are collected from wild habitats, but recently efforts have been made to introduce technologies for sustainable farming of selected insect species. This mirrors the country's efforts in various sectors - to build upon tradition, while integrating modern practices, in addressing development challenges.

This publication chronicles the fascinating traditions and modern efforts to enhance the contribution of edible insects to food security and improved nutrition in Lao PDR. It describes the most commonly consumed insects, details collecting and management practices, introduces the fledging insect farming sector, and presents experience related to food safety, processing, handling, marketing and consumption of edible insects in Lao PDR.

Food security in the future will require contributions from many sources - modern and traditional, old and new. The Lao PDR experience highlights the potential for building on traditional practices to address the modern challenges of food security and nutrition.

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