Small scale beekeeping and awareness raising on pollinators conservation for smallholders farmers in Siem Reap province – APICI project

Preliminary survey

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1. Introduction

"Developing Sustainable Agriculture for smallholders in Siem Reap Province", a project implemented by GRET and CIRD conjointly with the Department of Agriculture of the Province of Siem Reap, aims at supporting small-scale farmers on agro ecology transition meanwhile improving market access for local and environmental-friendly products. The project team is supporting around 1800 farmers in 50 villages, in two districts Sotr Nikum and Prasat Bakong.

The main project objectives include: (1) to intensify and diversify agricultural production following agro ecology approaches; (2) to increase income of smallholder farmers through better promotion of local products in Siem Reap's market; (3) to promote and strengthen professional and social farmer organizations in rural area; (4) to set up local network for agro ecology dissemination.

GRET and CIRD consider agro ecology as a solution for Cambodian farmers to increase their incomes, improve the soil fertility and reduce the use of chemical pesticides.

Agro ecology encompass a vast array of techniques and approaches that can be chosen and adapted to fit specific circumstances, needs and resources of the farmers for a sustainable family farming.

Pollination is the highest agricultural contributor worldwide, contributing far beyond any other agricultural management practice. Not only the presence of pollinators is important, but crops yields are improved in both quantity and quality by an abundant (size of populations) and diverse (number of kinds) pollinators population.

In Cambodia, bees and other pollinators are often threatened by agricultural practices (monoculture, pesticides…), ecosystems degradation and destructive honey hunting. Farmers are not usually willing to manage their lands to protect pollination services, either because they ignore the importance of pollinators or because they consider pollination service as an unsolicited "free service", or as a "public good".

Nevertheless, the implementation of simple measures to restore and increase the pollinator's population (education on pollination and the importance of pollinators conservation, native bee conservation, small scale beekeeping, improved land management…) can have positive impact on crops yields.

Further than contributing to crops pollination, beekeeping can also provide additional incomes to rural communities and help improving their livelihoods. The development of beekeeping may also contribute to the agro-ecological transition of small scale farmers through a better understanding of the challenge of pesticides uses. While the impact of pesticides on feral bee colonies is usually not documented, beekeepers are often very proactive activists against pesticides. In the northern Laos province of Oudomxai, beekeepers (AESBO association) play an active role in refraining the use of pesticides in their villages.

This report, documents the findings of a feasibility study regarding small scale beekeeping development in the framework of APICI project. The survey was conducted in 3 bio geographical zones (high land, middle land and low land) and examined 4 main topics:

1. farmers' understanding of pollination and interest of providing trainings on this topic;
2. small-scale beekeeping feasibility;

3. interest of native bee conservation and small-scale beekeeping to increase farmers' crops' yields;
4. honey production and trade in the province of Siem Reap.

2. Survey site

The survey was conducted on September 16, 18 and 19 2019 in 6 villages of Sotr Nikum district: Chrey Khang Tboung (low land); Chob and Rumdeng (middle land); Trach Pok, Trapeang Trav and Prum Kot (high land) (Figure 1 & Table 1).

Figure 1: The survey was conducted in 6 villages of Sotr Nikum district

Table 1: Surveyed villages and number of participants to focus group discussions

Bio-geographical zone	Commune	Village	Interviewees (women)
Low land	Kien Sangkae	Chrey Khang Tboung	12 (6)
Middle land	Khnar Pou	Chob	11 (4)
	Khnar Pou	Rumdeng	20 (12)
High land	Popel	Trach Pok	9 (7)
	Popel	Trapeang Trav	11 (7)
	Ballangk	Prum Kot	23 (18)
Total			**86 (54)**

3. Farmers understanding of pollination and interest of providing trainings on this topic

3.1 Survey methodology

Regarding pollination, we aimed at answering 3 questions:

1 What is farmers knowledge level on pollination and on the importance of pollinators for their crops?
2 Are farmers aware that some of their behaviors might threaten pollinators?
3 Would farmers be interested by trainings related to pollination and would they be receptive to messages related to bee conservation?

The evaluation of farmers' understanding on pollination was conducted through focus group discussions in each village. The discussions were sparked by slideshows and short videos.

The first part of the discussion focused on the process of pollination and pollination agents (Figure 2).

Figure 2: Introduction to the role of pollinators in vegetable production

Then participants were invited to reflect on the threats on pollinators communities and practical measures to increase pollinators populations (Figure 3).

Figure 3: Introduction to the impact of pesticides on pollination

The concpet of improved pollination was finally introduced (Figure 4).

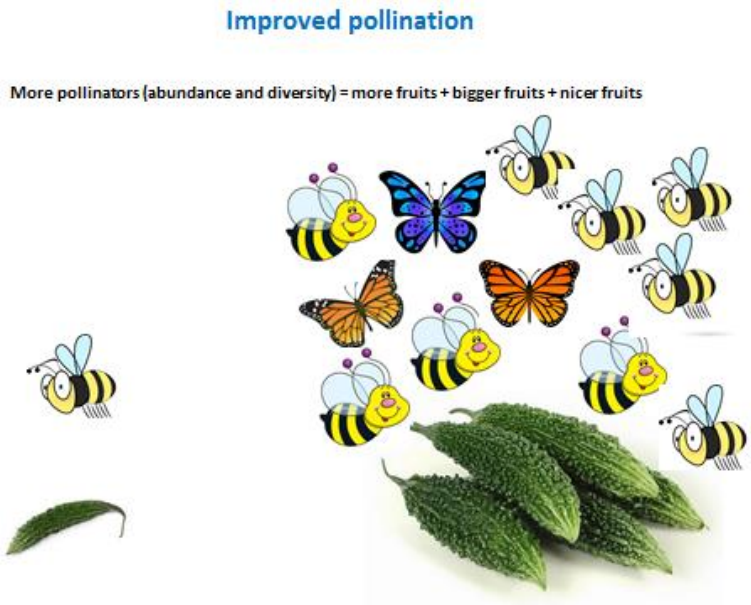

Figure 4: Introduction to the benefit of an increased pollinators population

3.2 Farmers' understanding of pollination and awareness on pollinators conservation

With rare exceptions, farmers have very low or no knowledge on pollination. The answer of a farmer from Trach Pok to the question "what is important to produce fruits and vegetables?" illustrates the lack

of knowledge of the majority of them: “we plant seeds, we water, give fertilizers and we spray pesticides and then we harvest vegetables”. Most farmers consider insects visiting their farm as a potential threat to their crops without distinction between pests and pollinators. A few acknowledged that some insects such as bees might be safe for their crops but others expressed their concern that too many bees visiting a flower might damage it.

Some participants reported situations that they couldn’t interpret at the time but for which, in the light of information received during the focus group discussion, they were wondering about a possible link with a lack of pollinators. A lady from Trach Pok: “sometimes my plants look good, I observe flowers but then no fruit come!” Another lady form the same village observed that sometimes she didn’t get fruits after spraying pesticides on flowers.

Among the 86 participants to the focus discussions, only one lady (Trapeang Trav) had basic knowledge’s about pollen transportation by bees between flowers and a man (Romdeng) was aware of the importance of bees for pollination and the consequence of spraying pesticides on flowers.

3.3 Farmers interest for trainings on pollination and receptivity to messages related to bees and pollinators conservation

Though our brief introduction didn’t aim at providing a comprehensive presentation of pollination and its challenges for agriculture, we were positively surprised by the interest of participants. They asked very relevant questions and often showed proactivity in suggesting measures to protect pollinators and improve the pollination of their crops.

In addition, farmers seemed to be very receptive to messages related to the importance of pollinators conservation. At the end of the discussion, many farmers acknowledged the importance of protecting pollinators. A lady from Trapeang Trav: “now I understand about the importance of bees and that we should start bee conservation”. A farmer from Chrey Khang Tboung expressed his concern that there might not be enough bees in the future to pollinate his vegetables. A couple of farmers suggested planting flowers and other bee plants to increase the number of bees visiting their village and to maintain them over longer period of time (most native Asian honeybees are migrating species).

The farmer from Romdeng who was aware of the importance of bees for pollination and of the consequence of spraying pesticides on flowers is also a honey hunter (he collects honey from feral bees colonies) and he used to join training on the effect of pesticides on pollinators. This highlights the positive impact of trainings on pollination and involvement in bee-related activities on farmers awareness on pollinator conservation.

3.4 Suggestions

The positive impact of the brief introduction given in 6 villages highlights the feasibility and usefulness of awareness campaigns on pollination and pollinators conservation. The training could cover the following topics:

- Pollination and its impact on fruits and vegetables yields;
- Pollinators agents;
- Importance of abundant and diverse pollinators communities;
- Threats on pollinators communities (pesticides, deforestation, loss of natural ecosystems in farms vicinity, unsustainable honey hunting…);

- Practical measures to preserve/increase pollinators populations (agro-ecology, forest conservation, conservation of (semi-)natural ecosystems around fields, sustainable honey hunting, beekeeping…).

4. Beekeeping feasibility

4.1 Survey methodology

The beekeeping feasibility was assessed for the Eastern honeybee (*Apis cerana*) and stingless bees (meliponiculture). The feasibility of rafter beekeeping (see 6.2.1 "Wild honey collection") with the Asian giant honeybee (*Apis dorsata*) was also explored but no suitable forest could be identified in any of the villages visited.

Three parameters were assessed:

1. Bee plants (nectar and pollen sources) abundance and seasonality;
2. Native bees abundance and seasonality;
3. Farmers interest in beekeeping.

The density and quality of nectar and pollen sources, also called the carrying capacity, determine whether beekeeping is feasible in an area. The distribution of nectar and pollen sources throughout the year gives indications on potential food scarcity periods and determines when honey harvest can be expected.

The bee forage assessment is conducted within the bees foraging range. The foraging range is the distance from the hive within which bees usually collect nectar and pollen. It differs from species to species. Even though *Apis cerana indica* (*Apis cerana* subspecies present in Cambodia) may forage up to 6-700 m away from the hive, the efficient foraging range is probably only about 3 - 400 m. The small stingless bee species suitable for beekeeping in the region have short flying range; probably in the range of 1 or 200 m.

Information related to bee plants were collected during the focus group discussions, confirmed and completed by field observations. In the scope of this preliminary survey, our objective was not to undertake a comprehensive bee plants inventory but to identify the presence of major bee plants and to evaluate their abundance. In particular, bee plants present in forest areas couldn't be inventoried in detail.

The native bee species assessment gives several relevant indications in the perspective of beekeeping development and in particular on the abundance and seasonality of bee forage. Further than an indication on the suitability of the environment, the presence of *Apis cerana* and stingless bee colonies will also be an opportunity to initiate beekeeping with local populations of native bees (by capturing swarms and transferring colonies to hives).

Information related to the presence of native bees were collected during the focus group discussions and completed during specific meetings with honey hunters and confirmed by field visits to observe bee nests (*Apis cerana* and stingless bees) or wax marks indicating prior *Apis dorsata* colonies settlements.

4.2 Main bee plants in Sotr Nikum district

The main bee plants found in the villages visited are the following:

Table 2: Some bee plants in and near the visited villages

English Name	Scientifique Name	Blooming	Remark
Cashew	Anacardium occidentale	02 (02 – 03)	
Betel nut	*Areca catechu*		
Sugar palm	*Borassus flabellifer*	yearlong	
Lemon	*Citrus limon*		
Orange	Citrus sinensis	01	
Coco nut	*Cocos nucifera*	yearlong	
Velvet tamarind	Dialium cochinchinense	08 - 09 (& 04 - 05?)	Krolang in Khmer
Snake root	Eupathorium pudicum	09 - 12	
Mimosa	Mimosa pudica	yearlong	
Banana	*Musa sp.*	Yearlong ?	Stingless bees
Korlan (Wild lychee)	Nephelium hypoleucum	02	Semoan in Khmer
Jujube	Ziziphus jujuba	08 – 12 (05?)	
Sesame	Sesamum indicum	2 blooms between 05 and 10	
Khnar Pou Community Protected Forest		10 - 12 & 03 - 04	Chob, Romdeng and Trach Pok
Forest		08 - 09	Trach Pok and Trapeang Trav
Forest APSARA		10 - 05	Prum Kot

4.3 Brief presentation of native bees in Cambodia

Cambodia is blessed with 4 indigenous honeybee species (*Apis dorsata, Apis florea, Apis andreniformis* and *Apis cerana*) and at least 14 stingless bee species (Ascher, et al., 2016).

4.3.1 Asian giant honeybee (*Apis dorsata)*

Also called the Asian giant honeybee (ឃ្មុំធំ) due to its respectable size (17–20 mm long) (Figure 5), *Apis dorsata* built its massive single-comb nest (up to 1.5 m long by 1 m high) in exposed places far off the ground, usually hanging beneath a tall tree branch, under cliff overhangs and sometimes on buildings (Figure 6). Nests of Apis dorsata may occur singly or in groups; it is not uncommon to find 10–20 nests in a single tall tree, known locally as a “bee tree”. In India and Thailand, tree harboring more than 100 nests are occasionally seen in or near tropical forests.

Figure 5: Apis dorsata (Siem Reap, Cambodia).

Apis dorsata colonies frequently undergo seasonal migration between alternative nesting sites, following flower blooms. Absconding swarms can travel distance up to 200 km in their seek for suitable habitat. Local migration patterns of *Apis dorsata* colonies are not well characterized.

Figure 6: Apis dorsata (Siem Reap, Cambodia).

Depending on flower resources, a colony can commonly produce 10 to 15 kg of honey per year.

Major pollinator for numerous wild plants and crops in the region, the Asian giant honeybee also has the particularity of being crepuscular and to forage throughout the night if a moon half-full or larger is present in the sky. This unique characteristic among honeybees makes the species a crucial pollinator of nocturnal-flowering trees or crops, such as the dragon fruit.

4.3.2 Dwarf honeybees (*Apis florea* and *Apis andreniformis*)

The black dwarf honeybee, *Apis andreniformis* (ឃ្មុំខ្មៅតូចតាមខ្នាត) and the red dwarf honeybee *Apis florea* (ឃ្មុំក្រហម), are sister species (Figure 7) with a partially sympatric distribution in southern Asia. As their names imply, they are the smallest species of honeybee (worker bees ranging from 7 to 10 mm).

Figure 7: The two dwarf honeybee species, Apis florea (left) and Apis andreniformis (right) (Phnom Kulen, Cambodia).

These subtropical and tropical honeybees construct a small single comb in the open. Nests, commonly found hanging in small trees, shrubs, or bushes are usually hidden behind leaves or branches to avoid detection (Figure 8). The comb architecture is similar to that in other apis species, except for the honey storage portion that is constructed around the supporting branch.

Figure 8: Apis florea nest (Chiang Mai, Thailand).

The bees have a short flight range, often hardly reaching 100 m from the nest. The maximum distance they can fly from the nest for foraging is often less than 750 m (*Apis florea*). The honey stock is usually limited to a few hundred grams. As forage is usually available only in limited periods, colonies often migrate from one area to the other.

Apis florea has a much wider distribution than *Apis andreniformis* and seems to be much more abundant within its distribution area. In Cambodia at least (but similar situations are reported from neighboring countries), *Apis andreniformis* is quite rare and patchily distributed (Ascher, et al., 2016).

Apis andreniformis is generally more defensive than *Apis florea*; it is known to attack when there are disturbances 3–4 m from the nest.

4.3.3 Eastern Honeybee (*Apis cerana*)

Apis cerana, the Eastern honeybee (ឃ្មុំ) (Figure 9), could be considered as the Asian counterpart of the European honeybee, *Apis mellifera*: both species are multiple combs cavity nesting and can be kept in hives. *Apis cerana* is slightly smaller (in size) and forms smaller colonies than *Apis mellifera* and its foraging range is usually limited to a few hundred meters. Feral colonies of *Apis cerana* are commonly found in tree hollows, clefts in rocks and walls.

Excellent pollinators for numerous crops, *Apis cerana* is often *managed for both honey production and pollination.*

The subspecies present in Cambodia is *Apis cerana indica*.

Figure 9: Apis cerana (Oudomxay, Laos).

4.3.4 Stingless bees

Stingless bees are not honeybees strictly speaking as they belong to another group of bees (tribe Meliponini). Nevertheless, they also produce honey and some species are managed into hives. Among other characteristics, these bees don't have the ability to sting.

Stingless bees have a couple of singularities (Figure 10) when compared to honeybees (Apis): (1) brood, pollen and honey are stored separately in small "pots" instead of hexagonal cells and brood is built horizontally; (2) bees don't feed their larvae; cells are capped once the queen has laid an egg on a mixture of pollen and honey. Their nest is easily recognizable with its entrance tube composed of wax and plant resins.

Figure 10: Stingless bee characteristic tubular nest entrance (Phnom Kulen, Cambodia) and pots based nest structure (Battambang, Cambodia)

Stingless bees are of great importance as pollinators and are used in several countries of South East Asia for pollination services (Figure 11). Several stingless bee species are also amenable for meliponiculture (stingless bee-keeping) and meliponiculture is widely developed in several South East Asian countries.

Figure 11: Stingless bee foraging (Chiang Mai, Thailand).

4.4 Beekeeping potential of the 6 villages visited

4.4.1 Chob and Romdeng

Located on the hedge of Khnar Pou Community Protected Forest (Figure 12), Chob and Romdeng villages are also heavily forested with high abundance of coconut, sugar palm, betel nut and banana (Figure 13). Numerous forest trees are also present in the villages; some of them such as krolang, semoan … being good source of nectar and/or pollen. Cashew nut is abundant and lemon, guava, neem, dragon fruits, kapok and jujube are present. Participants mentioned two small lemon farms (50 and 100 trees) in Chob village.

Figure 12: Khnar Pou Community Protected Forest at the hedge of Chob and Romdeng villages

Figure 13: Betel nut trees in Chob village

Apis dorsata is abundant in Khnar Pou Community Protected Forest (Figure 14) during the dry season (October to May) and a few colonies also usually nest in the villages. Surprisingly the population of *Apis dorsata* nesting in the Community Protected Forest seems to have substantially increased since 2017.

This situation is quite unusual in Cambodia where the populations of the species are generally stable or declining. Though this remains to be confirmed, the unusual colonies abundance could be linked to the degradation of other nesting sites in the area (deforestation).

Figure 14: Wax remains on a tree in Khnar Pou Community Protected Forest (Romdeng village) confirm the presence of Apis dorsata.

Apis florea is also abundant in the forest and present in the villages. The presence of the black dwarf bee, *Apis andreniformis*, was reported in Khnar Pou Community Protected Forest by honey hunters. *Apis cerana* is present though not abundant. Among the possible causes of the low *Apis cerana* population are: (1) the lack of suitable nesting sites such as hallow trunks in the secondary growth forest nearby, (2) the quasi systematic destruction of nests by the villagers and (3) the use of pesticides.

A couple of stingless bees nests were reported by the villagers (Figure 15). There are certainly many more as farmers didn't seem to pay much attention to these bees of which they ignore the economic value.

Figure 15: Stingless bees colony nesting in a hearth made rice attic (Chob village).

Apis dorsata and *Apis florea* are intensively hunted in Khnar Pou Community Protected Forest. The recent increase of *Apis dorsata* population resulted in a dramatic intensification of honey hunting. In the past two honey seasons, Khnar Pou Community Protected Forest attracted numerous honey hunters from other districts (or provinces) in their search for bee nests. Whole nest harvest (brood and honey) is widespread among honey hunters and the use of insecticides also frequent. The Protected community forest committee seems to have the willingness to control this activity but to be overtaken by the extend of the phenomenon.

4 honey hunters are still active in Romdeng village; 2 of them joined our presentation. Chob village doesn't count anymore professional honey hunter but farmers still opportunistically harvest nests of Apis dorsata and Apis florea that they come by. Farmers not familiar with honey harvesting often use destructive methods such as spraying insecticides or burning the bees.

Chob and Romdeng villages are suitable for beekeeping with both *Apis cerana* and stingless bees (Figure 16). The important population of *Apis dorsata* nesting in Khnar Pou Community Protected Forest between October and April (May) confirms an abundance of bee forage during the dry season with two main blooms (as specified by honey hunters): October to December and March to April. Sugar palm, coconut and betel among others, are very likely providing nectar and pollen almost all year round. Though beekeeping might be feasible in the whole villages, farms located on the eastern part of the villages might have an advantage as they are closer to the forest.

Figure 16: Suitable areas for beekeeping in Chob and Romdeng

The use of pesticides in the village might be a threat to beekeeping; farmers reported spraying on both flowers and fruits. Some farmers also grow corn (sweet corn is a source of pollen) after harvesting rice. Systemic insecticides commonly used to coat corn seeds are considered as the most toxic pesticides to bees.

4.4.2 Trach Pok

Trach Pok is less forested than Chob and Romdeng. However, the village stands between two forests which might provide beekeeping possibilities.

Beekeeping is very likely feasible in the 6 farms located along Khnar Pou Community Protected Forest on the West side of the village (Figure 17).

Figure 17: Farms located on the Eastern hedge of Khnar Pou Community Protected Forest are suitable for beekeeping (Trach Pok)

The forest on the eastern hedge of the village seems to have a different floral composition to that of Khnar Pou Community Protected Forest as suggested by a specific migration pattern of *Apis dorsata* colonies. According to honey hunters interviewed in Trach Pok and Trapeang Trav, most bee colonies migrate in the forest around June and migrate out between October and December. The main bloom usually occurs between August and September. The nectar flow seems to be quite abundant as honey hunters reported harvesting honey 2 weeks only after colonies settlement. A few colonies nest in the forest during the dry season but they do not produce much honey. The presence of *Apis dorsata* colonies during the rainy season in this area could also be linked with to the culture of sesame mentioned by honey hunters near the forest. Sesame is considered as an excellent bee plant.

The farming method in cassava plantations near the forest should be checked as neonicotinoid insecticides are frequently used in cassava farming. Beekeepers in Siem Reap province reported loses in their apiaries following bee foraging in cassava fields. Though Cassava is not a particularly good bee plants, gustative drops secreted by the leaves can still intoxicate bees and weeds growing in cassava fields can also be contaminated by neonicotinoids.

Participants reported the presence of a couple of *Apis cerana* and stingless bees nests of in the village. The population of *Apis florea* has decreased in the past 2-3 years but the species is still abundant. *Apis dorsata* is rare in the village.

The eastern and western parts of the village should be suitable for beekeeping with both *Apis cerana* and stingless bees (Figure 18), though bees might face food scarcity periods in the dry season (eastern part) and in the rainy season (western part). The location and extend of sesame farms should be specified.

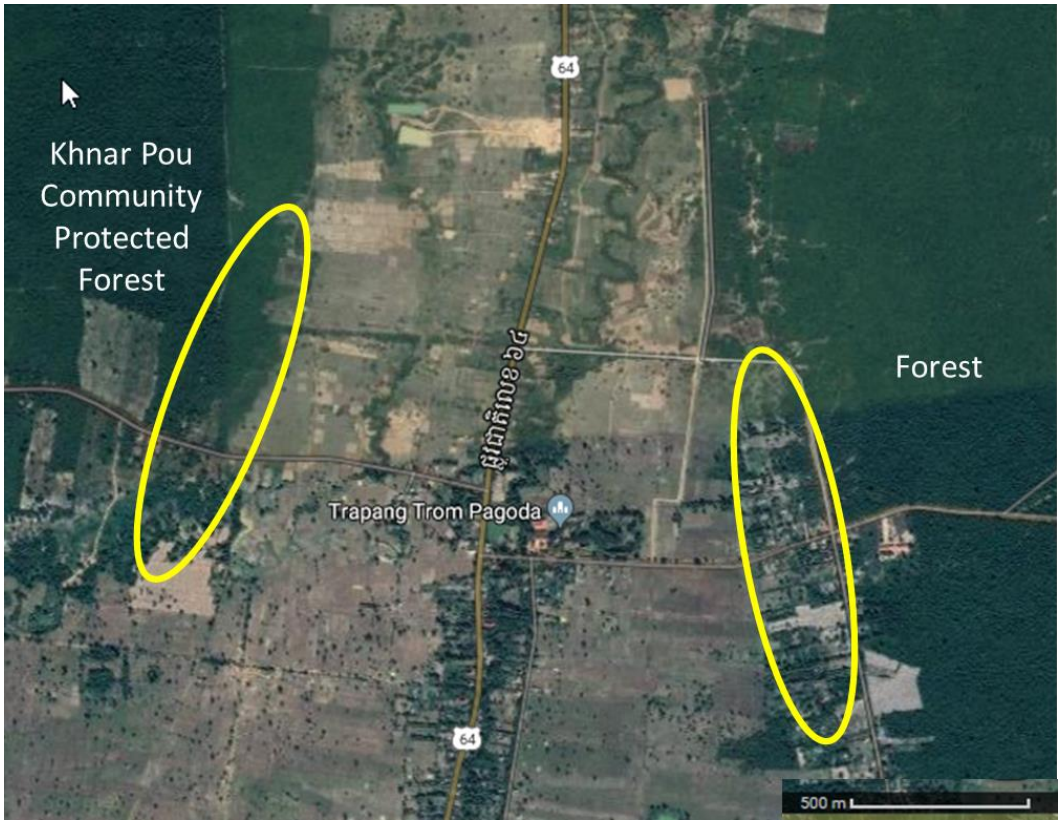

Figure 18: Suitable areas for beekeeping in Trach Pok

4.4.3 Trapeang Trav

Trapeang Trav borders the Eastern part of the forest located between Trach Pok and Trapeang Trav. Most families have coconut, sugar palm and cashew nut in their garden; many have orange, lemon, bananas, neem, guava and forest trees …

A few *Apis dorsata* colonies nest in the village during the rainy season and a few *Apis cerana* colonies yearlong. Farmers reported *Apis florea* and *Apis andreniformis* colonies nesting at the back of their houses (near the forest) after the rice harvesting season (November - December). As nest are usually collected by farmers before colonies naturally migrate, the migration out season couldn't be specified.

Trapeang Trav village is suitable for beekeeping with both *Apis cerana* and stingless bees (Figure 19). Though most farms of the village are suitable, those located on the western side of the road may have a higher beekeeping potential as they are closer to the forest.

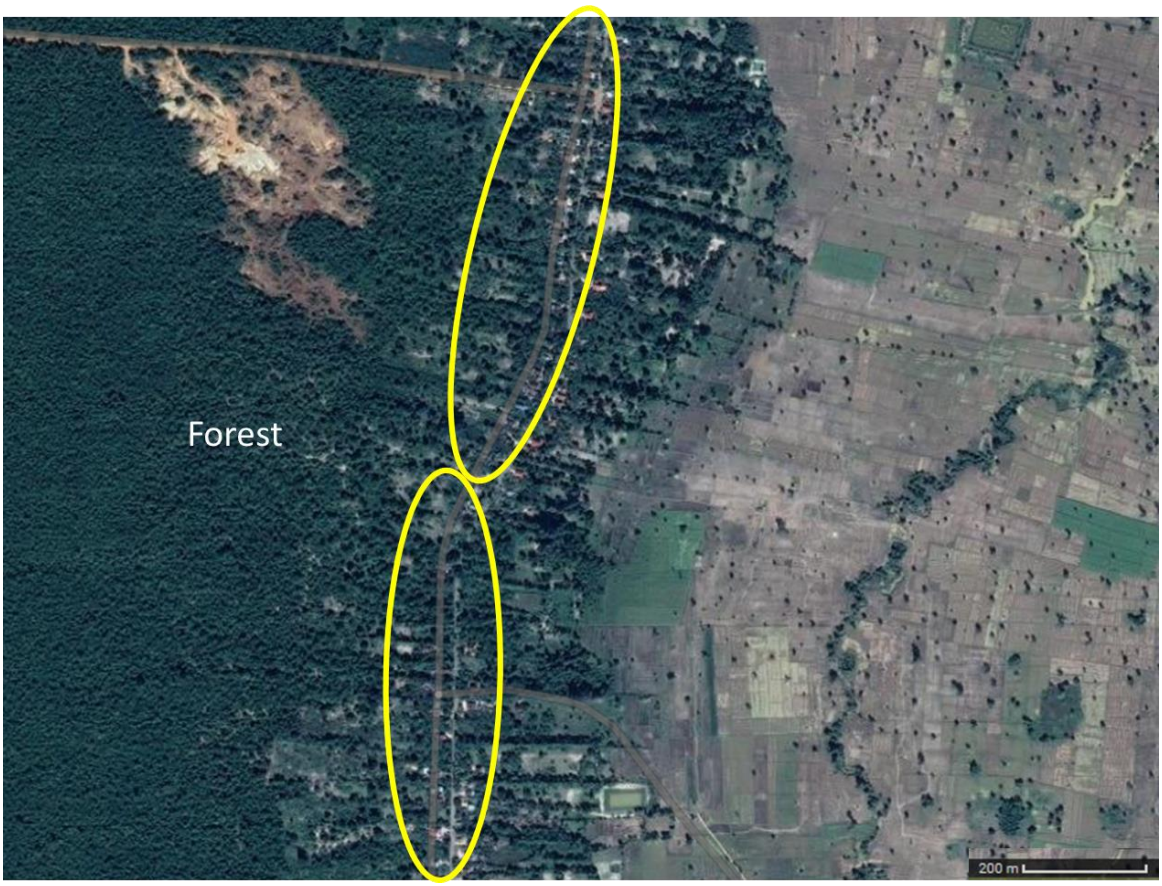

Figure 19: Suitable areas for beekeeping in Trapeang Trav

4.4.4 Chrey Khang Tboung

Chrey Khang Tboung village is surrounded by rice fields. Though sugar palm are still abundant and bee plants are present in most gardens, the village remains globally poorly forested.

Some farms might however have the **capacity** to **carry a couple of bee boxes, in particular stingless bees**. For example, a farm with 100 jujube trees, numerous sugar palm and coconut trees as well as some oranges (Figure 20). Sugar palm and coconut usually bloom during almost all year round and the farmer specified that his jujube trees were blooming from August to December and possibly until May if they have enough water.

Figure 20: A jujube farm in Chrey Khang Tboung

A 150 m wide by 2 km long strip of forest in the nearby village of Kouk Reussei Khang Tboung might offer a slightly higher beekeeping potential (Figure 21).

Figure 21: A farm in a strip of forest and Velvet tamarind (*Dialium cochinchinense*) blooming (Kouk Reussei Khang Tboung)

Farmers reported a dramatic decline of the bee population in the area. A few *Apis dorsata* colonies are still observed sometimes. Even *Apis florea* is not very abundant. A villager from the nearby village of Chrey khang Cheung reported Apis cerana colonies nesting in hallow coconut trunks (Figure 22) in his orange farm (100 trees). Colonies usually settle in May and abscond a few days following herbicides spray in the surrounding rice fields (August).

Figure 22: Apis cerana colonies nest every year in these two hallow coconut trunks (Chrey khang Cheung)

Among all the villages visited, **Chrey Khang Tboung has the lowest potential for beekeeping (Figure 23)**. However, some farms may have the capacity to carry a few stingless bee boxes. Beekeeping in Chrey

Khang Tboung might mainly be considered as a support to pollination as **this area is very likely the most exposed to pollinators shortage**.

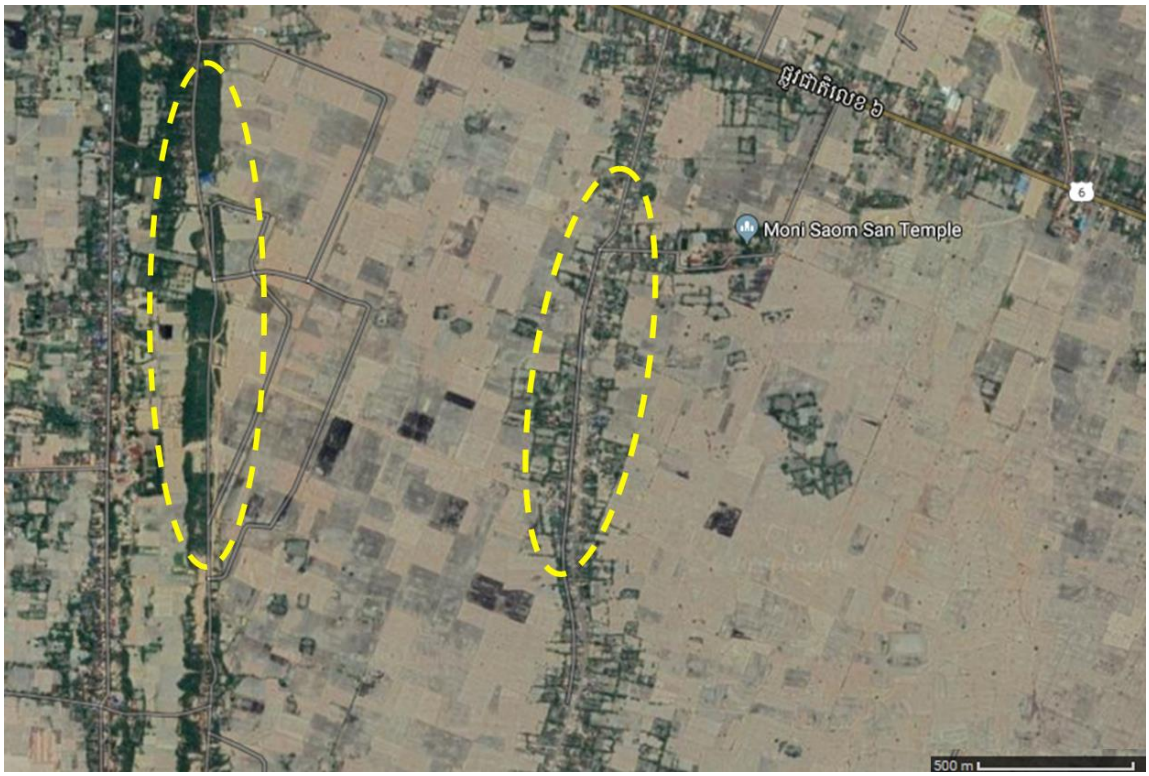

Figure 23: Suitable areas for beekeeping in Chrey Khang Tboung

4.4.5 Prum Kot

Prum Kot borders the southern moat of Prasat Klaeng and Chaw Srei Vibol temples and their 40 hectares protected forest (APSARA). Sugar palm trees are very abundant; coconut, cashew nut, banana, guava… are also present in the village.

According to famers, though not abundant, *Apis cerana* and *Apis florea* colonies nest in the village and it's surrounding every year. *Apis cerana* bees were observed foraging on a blooming tree at the entrance of the village. Farmers reported a dramatic decline of *Apis dorsata* population in the past years. Some colonies are still nesting between October and May in the nearby APSARA forest.

Stingless bees seem to be quite abundant in the area. 6 nests were found within a 20 minute search (Figures 24 & 25).

Figure 24: Entrance of Stingless bee nests (Prum Kot). These small stingless bee species are suitable for meliponiculture

Figure 25: Entrance of a Tetragonula collina nest (Prum Kot). This species is not suitable for meliponiculture.

Prum Kot is suitable for beekeeping with both *Apis cerana* and stingless bees (Figure 26). The farms located in the northern part of the forest village might have the highest beekeeping potential as bees would benefit from both a 50 m wide strip of forest and palm trees. From there, *Apis cerana* would also

be able to forage in the APSARA protected forest (Figure 27) and to access most sugar palm trees of the village (Figure 28).

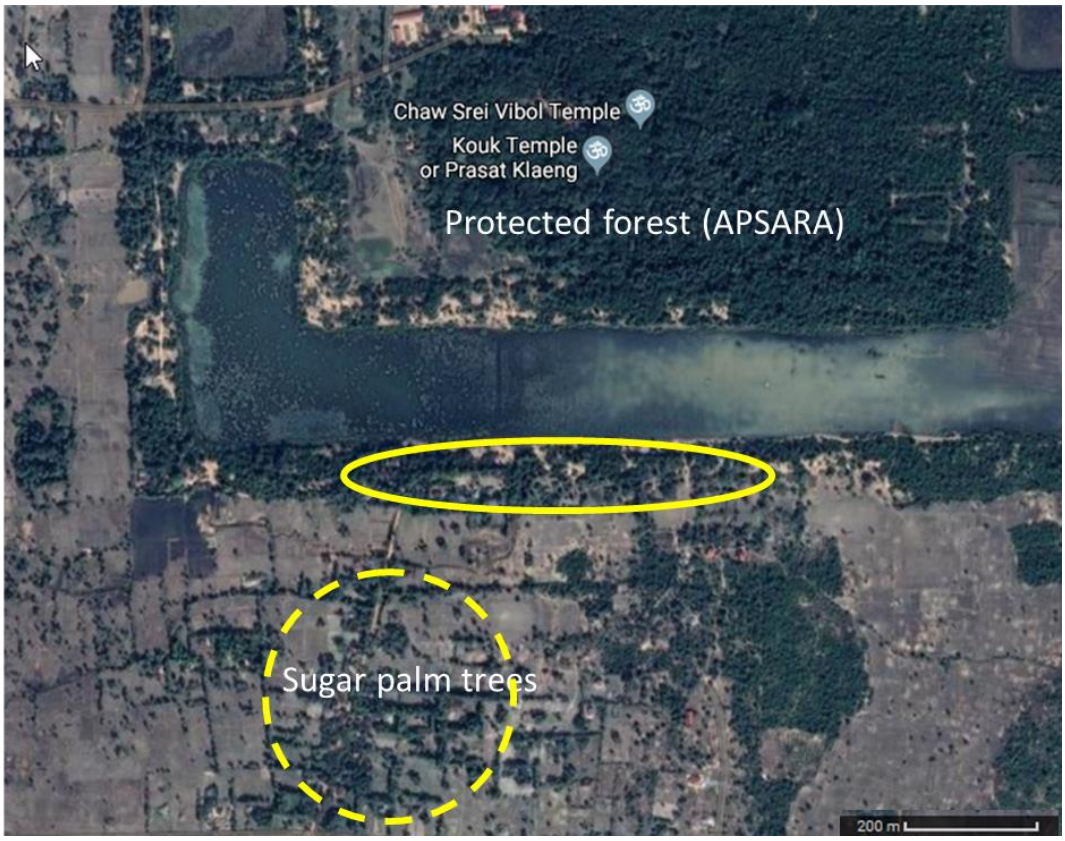

Figure 26: Suitable areas for beekeeping in Prum Kot

Figure 27: A 40 hectares APSARA protected forest should be accessible by Apis cerana foragers (Prum Kot)

Figure 28: High density of sugar palm trees (Prum Kot)

4.5 Farmers interest for beekeeping

Although our succinct introduction could only give farmers a very partial overview on beekeeping, many of them expressed their interest for this new activity. This positive feedback is encouraging. However, a more comprehensive presentation of the activity, including its potential benefits and constraints will be necessary as part of the identification of pilot beekeepers.

4.6 Technical recommendations for beekeeping development

4.6.1 Which beekeeping?

Three options are possible for beekeeping in Cambodia:

1. Beekeeping with the introduced western honeybee (*Apis mellifera*);
2. Beekeeping with the Eastern honeybee (*Apis cerana*) (Figure 29);
3. Meliponiculture: beekeeping with stingless bees (Figure 29).

Whereas beekeeping with native bees is well developed in many South East Asian countries, it is still nearly inexistent in Cambodia where beekeeping has been developed with the introduced western honeybee (*Apis mellifera*).

Apis mellifera presents the advantage of producing more honey than *Apis cerana* and stingless bees. On another hand, beekeeping with *Apis mellifera* requires higher investments and skills. As the species is not native, it is more sensitive to local predators, parasites and diseases. In addition, their longer forage range increases western honeybees exposure to pesticides. In addition, bee products from native bee are usually sold at higher prices than those from *Apis mellifera*.

Figure 29: Meliponiculture in Thailand (left) and beekeeping with A cerana in traditional log hive, Laos (middle) and movable frame hives, Vietnam (right).

Moreover, despite its large development throughout Asia, beekeeping with *Apis mellifera* is still controversial due to its potential adverse impacts on native honeybees and in particular the spread of pests and diseases and competition for floral resources. A recent survey conducted on 16 Asian countries, showed an average 55% decrease in *Apis cerana* populations over the past ten years (Theisen-Jones & Bienefeld, 2016).

Keeping native bees may also contribute to the restoration of local populations of these species. The introduction of *Apis cerana* beekeeping in Oudomxai province (Northern Laos) by AESBO resulted in a complete switch of the local bees population dynamic from decline to recovery.

From an environmental conservation perspective it is not only recommended to prefer native bees but also to work with local populations of these native species. In absence of native bee colonies suppliers in the area, a beekeeping project can still be initiated by capturing feral colonies or swarms.

4.6.2 Beekeeping with *Apis cerana*

Apis cerana is an important bee to beekeepers in Asia. Though it produces less honey than its western cousin, *Apis cerana* is more resistant to pests and diseases and beekeeping with the species requires lower investments and skills. As a result *Apis cerana* is often the choice of poor communities.

Apis cerana has traditionally been raised in several Asian countries (log hives) (Figure 30). Following the invention of the movable-frame hive for the European honeybee, traditional beekeeping with *Apis cerana* is progressively replaced by this modern method.

Figure 30: Beekeeping with Apis cerana in log hives (Lao Cia, Vietnam).

Apis cerana honey is often sold at higher price than Apis mellifera honey. In Vietnam, *Apis cerana* honey is usually 3 times more expensive than *Apis mellifera* honey.

Excellent pollinators for numerous crops, *Apis cerana* is often managed for both honey production and pollination.

Apis cerana is known to be a very docile, gentle, and even somewhat timid, but there can be large differences in their defensiveness depending on season and region. *Apis cerana* colonies tend to swarm (colony division) and abscond (colony abandoning their hive) more frequently than do *Apis mellifera* colonies. Thus, the main challenge of beekeeping with *Apis cerana* is the management of colonies absconding. Absconding designs the movement of a whole colony due to resource depletion, declining nest site quality or disturbance.

While widely spread in neighboring countries (Thailand, Laos and Vietnam) and other Asian countries such as India, beekeeping with *Apis cerana* is barely absent in Cambodia (only a few colonies kept in Battambang).

4.6.3 Meliponiculture (beekeeping with stingless bees)

Stingless bee colonies differ from those of honeybees (Apis) in that the honey is stored in pots as opposed to hexagonal combs. While honeybee combs are composed solely of wax, stingless bee storage pots are varying mixtures of beeswax and plant resins, collectively known as cerumen. Individual pots are used to store nectar (honey) and pollen and can vary in size from very small (<5 mm in height) to large (>50 mm in height) depending upon the bee species. The horizontal, single sided brood combs are separated from the food storage pots and, depending on the stingless bee species, can be well organized into stacked brood combs, or agglomerations of brood cells. (Chuttong, Chanbang, & Burgett, 2014)

Stingless bees are of great importance as pollinators and are used in several countries of South East Asia for pollination services. Stingless bees are also used for beekeeping because they usually forage for their food source not far from the nest, can collect both pollen and nectar from various plant species, forage throughout the year, pollinate native plants as they are endemic insect pollinators, cannot sting, are of a small size with a long life cycle that is greater than other insect pollinators, and so are easy to handle, propagate and keep in small easily transported hive boxes for crop pollination (Heard, 1999) (Thakodee, Deowanish, & Duangmal, 2018).

A rapidly growing meliponiculture (stingless bee keeping) industry has developed (Jalil & Shubib, 2014) in several countries of the region (Malaysia, The Philippines, Indonesia...) (Ascher, et al., 2016) (Figure 31). Large scale meliponiculture is practiced in the Southeast Thailand centering on the provinces of Chanthaburi and Trat. This particular area in Thailand has a well-developed commercial fruit industry. (Chuttong, Chanbang, & Burgett, 2014).

Figure 31: Stingless bees honey in Malaysia and Meliponiculture in Thailand (Ratchaburi, Thailand).

Not all stingless bee species are amenable for meliponiculture due to the nature of their mature tree cavity nesting habitats. However, several species are adaptable to human-made homes. In Southeast Asia the foremost among these are species in the *Tetragonula laeviceps* and *T. pagdeni* species complexes which are very opportunistic in nest cavity selection and readily accept human-made domiciles. Other species presently being managed in Thailand include *Lepidotrigona flavibasis*, *L. doipaensis, L. terminate* (Figure 32) and *Tetragonula testaceitarsis*. (Chuttong, Chanbang, & Burgett, 2014).

Figure 32: Lepidotrigona terminate; one of the stingless bee species suitable for meliponiculture in Cambodia

In the eastern part of Thailand, four species of stingless bee (*T.pagdeni, T. laeviceps, Lepidotrigona terminata and L. ventralis*) have been kept in small wooden box hives for honey harvesting and agricultural crop pollination, including rambutan, litchi and cashew nut, with T. pagdeni being the dominant and most widely kept species in this area (Chuttong, Chanbang, & Burgett, 2014).

Even though the amount of honey from a stingless bee colony cannot compete with honeybees on a per colony basis (0.5kg per year on average in Thailand), stingless bee honey is of higher value due to its relative scarcity (Thakodee, Deowanish, & Duangmal, 2018). Thai stingless bee honey retails for 1,200 - 1,500 THB ($37-$47 USD) per kilogram, which is 10 times the price received for Thai produced Apis mellifera honey. (Chuttong, Chanbang, & Burgett, 2014). In addition to honey beekeepers can also get an income from selling cerumen with per kilogram returns of 1,500-2,000 THB ($47-$62 USD). A reasonable average cerumen production is 200 gram/hive/year, (Chuttong, Chanbang, & Burgett, 2014).

4.6.4 Suggestions to initiate beekeeping in Sotr Nikum district

Introducing a new activity to communities is always challenging and beekeeping is no exception to the rule! The implementation of a pilot project will allow:

1. To initiate the project with key farmers who may facilitate the expansion of beekeeping in a second step;
2. To confirm and refine the beekeeping potential of the area. Indeed, while the carrying capacity of monocultures such as fruits orchards (rambutan, longan…) or plantations (acacia, rubber, coffee, kapok…) is easy to estimate; it is a different matter when it comes to heterogenic ecosystems such as natural forests. Even though the forests in the vicinity of the villages are undoubtedly good sources of pollen and nectar, the heterogeneous distribution of bee trees might create significant differences in the carrying capacity within bees foraging range.

To increase the chances of success, the pilot project should ideally be implemented in a few villages and involve a minimum numbers of farmers. Both Apis cerana beekeeping and meliponiculture should be tested.

Pilot beekeepers should be selected according to their motivation for beekeeping and the location of their farm (proximity to bee plants). Farmers with extended knowledge on local bee flora could be involved in the identification of optimal apiaries in each village. A couple of resource persons could be identified during our field assessment. In particular a honey hunter from Romdeng village and couple in Prum Kot village could name tens of bee plants and specify their blooming seasons.

The beekeeping potential of each farm should take into account the foraging range of the targeted bee (Figure 33) :

- Apis cerana : 3-400m (up to 6-700m?)
- stingless bees: 1-200m

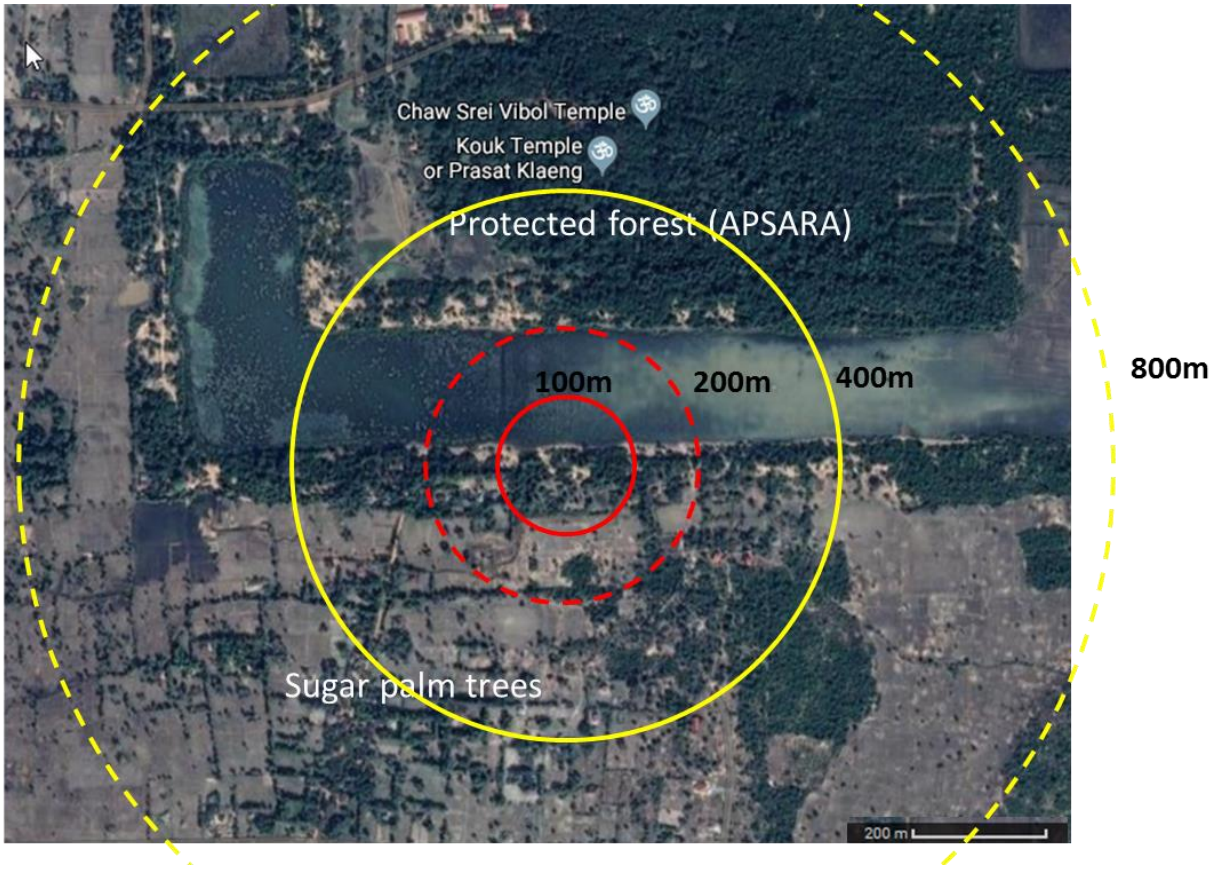

Figure 33: The foraging range of the targeted bee (Apis cerana or stingless bees) should be taken into account in the selection of pilot beekeepers.

Stingless bee colonies could be sourced in Eastern Thailand. Villagers could also be trained on feral colonies and swarms capture (Figures 34 & 35).

Figure 34: Stingless bee bamboo swarm trap (left) and pipe method to transfer inaccessible stingless bees nests into a hive (right)

Figure 35: Training on stingless bee colonies capture (Koh Kong, Cambodia)

Regarding *Apis cerana*, a few colonies might be sourced from Battambang. The risk of genetic contamination of local population should be assessed prior to importing colonies from Vietnam (more than 500 km and some beekeepers working with hybrids *Apis cerana cerana* x *Apis cerana indica*) or southern Thailand (more than 1000 km). Transferring feral nests of *Apis cerana* colonies (Figures 36 & 37) into hives should be restricted to easily accessible nests as the method can be quite destructive to bees and damage trees. Swarms capture should be privileged (Figure 35). The project might also be an opportunity to test an artificial swarm attractant developed by Prof. Fumio Sakamoto (Kyoto Gakuen University) and his team. This lure using active components from Oriental orchid (Cymbidium

floribundum) has been successfully tested on *Apis cerana japonica* in Japan and the team is interested to test it on *Apis cerana cerana* in Laos and *Apis cerana indica* in Cambodia.

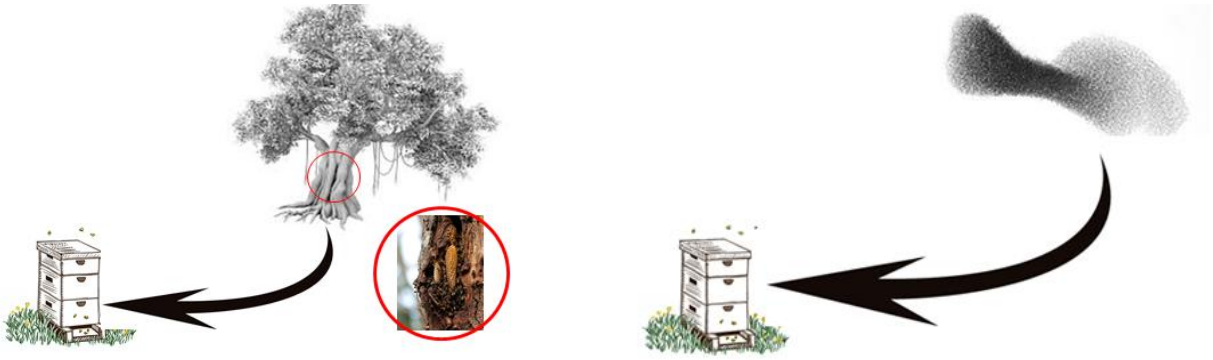

Figure 36: Apis cerana colony transfer (left) and swarm capture (right)

Figure 37: Trainings on Apis cerana feral nest transfer to a hive (Chiang Mai, Thailand and Mondulkiri, Cambodia)

5. Potential crops yields increase as a result of an improved pollination

5.1 Introduction

As bees gather pollen and nectar for their survival, they also pollinate crops. The Food and Agriculture Organization of the United Nations (FAO) estimates that out of some 100 crop species which provide 90% of food worldwide, 71 of these are bee-pollinated (UNEP, 2010). In Europe alone, 4 000 vegetable varieties exist thanks to pollination by bees (Williams, 1996). It is considered that pollinators (mainly, but not exclusively bees) increase the productivity of 70% of 1,330 tropical crops (Roubik, 1995).

Regarding crops yields and improved pollination, we aimed at answering 3 questions:

1. Which crops produced by farmers in Sotr Nikum district are pollinated by bees and to what extend bees contribute to their pollination?
2. Which crops would benefit from improved pollinators communities?
3. What practical measures could be implemented to restore/increase local pollinators populations?

5.2 Role of bees in the pollination of crops produced in Sotr Nikum district

A literature review was conducted to characterize the role of bees in the pollination of the fruits and vegetables produced by the farmers of Sotr Nikum district (Table 3). The list of fruits of vegetables includes the crops sold through Ecofarm (farmers' association) or other channels and crops self-consumed by farmers. For each crop, the bee species (or the group of bees) involved in pollination is specified. The type of commercial product of pollination (seed, fruit or nut) is also documented. Indeed, in many vegetable plants it is not the fruit that is eaten. However, insect cross-pollination is important in obtaining seeds of these plants (FAO, 1995). The importance of bee pollination is also classified as one of the following: essential, great, modest, and little.

Table 3: Fruits and vegetables pollinated by bees in the target villages (Modified from Wikipedia*)

Khmer Name	English Name	Latin Name	Pollinator	Commercial product of pollination	Pollinator impact
បន្លែស្លឹក និងផ្កា Leaves and flower vegetable					
ស្ពៃក្រញាញ់	Chinese cabbage	*Brassica rapa*	Honey bees, solitary bees	seed	1-little
ស្ពៃខៀវ	Green mustard	Brassica juncea	Honey bees, stingless bees (Neha, Kumar, & Khan, 2014) A. dorsata, A. mellifera, A. cerana, A. florea (Das & Jha, 2018)	seed	2-modest
ស្ពៃតឿ	Pock choy	Brassica rapa subsp. chinensis	Honey bees, solitary bees	seed	1-little
ស្ពៃក្តោប	Cabbage	*Brassica oleracea* Capitata Gr.	Honey bees, solitary bees	seed	1-little
ជីនាយ	Chinese celery	Apium graveolens var. secalinum	Honey bees, solitary bees, flies	seed	
ផ្កាខាត់ណាស	Cauliflower	*Brassica oleracea* Botrytis Gr.	Honey bees, solitary bees	seed	1-little
ដើមខាត់ណា	Chinese kale	Brassica oleracea Alboglabra Gr.	Honey bees, solitary bees	seed	1-little

Khmer Name	English Name	Latin Name	Pollinator	Commercial product of pollination	Pollinator impact
បន្លែផ្លែ និងមើម Fruit and root vegetable					
ត្រសក់ត្រែង	Cucumber	*Cucumis sativus*	Honey bees, squash bees, bumblebees, leafcutter bee, solitary Stingless bees (Sawatthum, Jitake, Rangyai, Prangprayong, Pimboon, &	fruit	3-great

			Suparit, 2014) (Heard, 1999)		
ត្រសក់ស្រូវ	Muskmelon	Cucumis melo	Honey bees, squash bees, bumblebees, solitary bees (Ceratina spp.)	fruit	4-essential
ត្រប់វែង	Eggplant	*Solanum melongena*	Bumblebees, solitary bees	fruit	2-modest (pollinators important in green houses, but less in open fields)
ត្រប់ស្រួយ	Crisp eggplant	*Solanum sp.*			
ត្រប់ផ្តាម	Round eggplant	*Solanum melongena*			
ត្រប់ពុតញង	Pea eggplant	Solanum torvum			
ល្ពៅ	Pumpkin	*Cucurbita* spp.	Honey bees, squash bees, bumblebees, solitary bees	fruit	4-essential
ននោងមូល	Sponge gourd	Luffa aegyptiaca			
ឃ្លោក	Bottle gourd	Lagenaria siceraria			
ត្រឡាច	Wax gourd	Benincasa hispida			
ម្រះ	Bitter gourd	Momordica charantia	Honey bees (A. mellifera and A. cerana), stingless bees (Trigona spp.) (Deyo & Cervancia, 2009) (Heard, 1999)	fruit	4-essential
ននោងជ្រុង	Angled luffa	Luffa acutangula	Honey bees (at least A. cerana and A. dorsata). Stingless bees ?	fruit	4-essential ?
ក្តឹបឪឡឹក	Watermelon (green)	*Citrullus lanatus*	Honey bees, stingless bees, flies, ants, wasps	fruit	4-essential
ម្ទេសហិរ	Hot chili (small)	Capsicum frutescens	Honey bees, Stingless bees (Melipona spp.)	fruit	1-little
ល្មុងខ្ចី	Papaya (young)	*Carica papaya*	Honey bees, thrips, large sphinx moths, moths, butterflies	fruit	1-little
រំដេង	Galangal	Alpina sp.	pollinated by large bees, but some are pollinated by birds and bats.		
អំពិលទុំ	Tamarind (ripe)	*Tamarindus indica*	Honey bees (incl. Apis dorsata)	fruit	1-little
ក្រូចឆ្មារ	Lemon	*Citrus limon*	Honey bees (also will often self-pollinated) Stingless bees (Heard, 1999)	fruit	
	Orange	*Citrus* spp.	Honey bees, stingless bees	fruit	1-little
	Grapefruit	*Citrus* spp.	Honey bees, bumblebees	fruit	1-little
ស្វាយខ្ចី	Mango (green)	*Mangifera indica*	Honey bees (also will often self-pollinate)	fruit	3-great
	Cashew	*Anacardium occidentale*	Honey bees, bumblebees, solitary bees	nut	3-great
	Coconut	*Cocos nucifera*	Honey bees, stingless bees, bumblebees, solitary bees (Centris tarsata), butterflies, flies, hummingbirds	nut	2-modest
	Guava	*Psidium*	Honey bees, bumblebees	fruit	2-modest

		guajava			
	Betel nut	*Areca catechu*	Honey bees, stingless bees, bumblebees, solitary bees (Lasioglossum spp.)	nut	
	Jujube	*Zizyphus jujuba*	Honey bees, solitary bees	fruit	2-modest

* https://en.wikipedia.org/wiki/List_of_crop_plants_pollinated_by_bees

Bees are involved in the pollination of 33 fruits and vegetables produced in the target villages. For most of them (26) the commercial product of pollination are fruits or nuts, while bee pollination results in the production of seeds for 7 leaves vegetables.

Bee pollination is very important (essential or great) for 10 fruits (cucumber, muskmelon, watermelon, pumpkin, sponge gourd, bottle gourd, bitter gourd, wax gourd, cashew nuts and mango) and of lower importance (modest and little) for 12 fruits and 6 leaves vegetables. The pollinator impact is uncertain for betel nut, lemon, galangal and Chinese celery.

5.3 Improved pollinators communities to increase farms crops productivity

Pollinators and pollination deficits cause reduced production (IPBES, 2018). For example, an experiment in India showed a 54.5% reduction in eggplants production when the plants were pollinators limited (Bhattacharya & Basu, 2016). In Chanthaburi province (Eastern Thailand), rambutan (Nephelium lappaceum) and durian (Durio zibethinus) farmers supplement their orchards insufficient pollination by adopting meliponiculture (Narjes, 2018).

On another hand, a well-pollinated flower will contain more seeds, with an enhanced capacity to germinate and will usually lead to bigger and better-shaped fruit. An optimized pollination can also reduce the time between flowering and fruit set, reducing the risk of exposing fruit to pests, disease, bad weather, agro-chemicals and save on water.

A high diversity (number of kinds) and abundance (size of populations) of pollinators in a single crop type can improve yields by maximizing the quantity and quality of the produce (IPBES, 2018). A world-wide study by Lucas Garibaldi et al. in 2013 found that the best yields were obtained when wild insects and honeybees pollinated crops together. https://www.aussiebee.com.au/croppollination.html.

Numerous researches have shown the positive impact of increased bee populations on crops productivity. In India, the introduction of *Apis cerana* bee boxes in vegetable fields significantly increased the fruit production of eggplant (+28%), gourd (+38%) and pumpkin (+ 43%) (Bhattacharya & Basu, 2016). In West Sumatera chili pepper plantation, pollination by stingless bees increased yields/ha by more than 50% (Dewirman, Dahelmi, Siti, & Etti, 2016). An increased number of bees visiting Angled luffa flowers results in a higher fructification rate, heavier and longer fruits and fruits with more seeds. (Jayaramappa, Pattabhiramaiah , & Bhargava, 2011).

In a research conducted in Chian Mai (Northern Thailand), Theanworrakant and colleagues (Theanworrakant, Chittima, Thophon, & Yapanan, 2016) showed the major role of stingless bees in bitter gourd pollination and the benefit of meliponiculture (beekeeping with stingless bees) combined with bitter gourd farming. Bitter gourd yields increased by 60 to 134% depending on the number of hives per rai (Table 4).

Table 4: Bitter gourd yields increase depending on the number of hives per rai

Hives/rai*	Bitter gourd Yield increase
4	+60%
8	+85%
12	+134%

*1rai = 1.600m2

On principle, the crops for which bee pollination is essential or great (Table 3) would benefit the most form an improved bee population. Plants with a lower dependence on bees for their pollination (modest and little) may also benefit from an improved bee population but to a lesser extent.

As part of this survey, no evidence of a pollination deficiency (famers complaining about low crops yields) was found in any of the village visited. A diversity of pollinators was observed on farmer's crops (butterflies, beetles, solitary bees, stingless bees and honeybees). Farms very likely benefit from the proximity of ecosystems favorable to a diverse pollinators population (forest, semi natural hedges…). However, it might be worthwhile conducting a more complete assessment of the pollinators commmunitites status and its implications on crops yields.

In addition, eventhough pollination doesn't seem to be currently a limiting factor in the area, it might be worth raising awareness of famers on the importance of preserving their pollinators communities and introducing a set of practical conservation measures to prevent any pollination deficiency in the future.

5.4 Suggestion to restore/increase pollinators populations

While insect pollinators and in particular bees contribute to the pollination of many fruits and vegetables, some famers behaviors (pesticides, destructive honey hunting) are obviously threatening pollinators populations.

The following paragraphs present a set of practical measures that could contribute restoring/improving local native bees populations. Though measures focus on native bees conservation, some of them should also benefit to other groups of pollinators.

5.4.1 Bees and pollinators friendly land management

Practical measures for a bee friendly land management:

1. Conserving or restoring (semi-) natural areas around the fields: semi natural hedges, old trunks, groves of trees around the fields can provide suitable food and nesting resources for, and enhance species richness and abundance of native bees and other pollinators.
2. Planting strips of bee friendly flowers (good source of nectar and/or pollen) to support bee colonies during food scarcity seasons and to enhance pollinators in crops fields.
3. Raising farmers awareness on the impact of pesticides on pollinators: killed by insecticides and deprived of floral resources provided by weeds by herbicides.

5.4.2 Preserving native bee colonies

Honey hunters methods in the area are usually destructive (whole nests collection, use of fire and insecticides to prevent bee stings) which contribute to the decline of bees populations.

Farmers should be encouraged to leave bee colonies alone or to use sustainable harvesting practices if they still want to collect honey. These technics consisting in harvesting only a part of the honey prevent colonies from absconding and usually allow multiple harvests. They should be introduced, not only to local farmers but also to honey hunters collecting honey from the forest near the villages. It might in particular be interesting to introduce these technics to the Khnar Pou Protected Community Forest Committee.

Sustainable honey harvesting from *Apis florea*:

Given its tolerance to disturbed habitats (urban, agricultural, secondary forest) the species is usually the most common native honey bee in the vicinity of the farms.

Sustainable honey harvesting method (Figure 38):

1. The brood is cut form the branch supporting the nest and around which most of the honey is stored,
2. The honey can be squeezed or sold as honey comb,
3. The brood part of the comb is pinched between the two slices of a small branch and hanged back in the tree.

Figure 38: Sustainable honey harvesting from Apis florea

Sustainable honey harvesting from *Apis dorsata*

Similarly to *Apis florea*, farmers should be encouraged to leave the colonies nesting in or near their village alone. However, the sustainable harvesting method should be introduced to limit the adverse impacts of honey hunting on *Apis dorsata* local populations.

Farmers could be trained: (1) to avoid fire and insecticides, (2) make and use proper smokers in order to avoid being stung while approaching the nest and driving the bees away (Figure 39), (3) to harvest only the honey head and leave the rest of the comb intact (Figure 40). Colonies harvested in a sustainable way soon start building a new honey head. This technic allows multiple harvests while preserving the bees.

Figure 39: destructive (insecticide and fire) and sustainable (smoke) methods to avoid bee stings

Figure 40: Unsustainable (left) and "honey head" only, sustainable honey harvesting (right) from of Apis dorsata nests. Photo Bees Unlimited

5.4.3 Beekeeping

As specified in paragraph 4.6 "Technical recommendations for beekeeping development", beekeeping could also contribute to improve the pollinators population. In addition, working with bees usually has a positive impact on farmers awareness on the adverse effects of pesticides.

6. Honey production and trade in Siem Reap province

6.1 Survey methodology

The survey on honey production and trade in Siem Reap was conducted as follows:

1. Interviews of honey producers (beekeepers and wild honey collectors) and honey traders in the province of Siem Reap,
2. Surveys at supermarkets, souvenir shops, markets in Siem Reap and along touristic roads (access to Phnom Kulen).

6.2 Honey production in Siem Reap province

Honey production in Siem Reap province has 2 origins:

1 Wild honey collection,
2 Bee farms.

6.2.1 Wild honey collection (honey hunting and rafter beekeeping)

Honey hunting

In Cambodia, wild honey is mainly collected from two species: the giant Asian honeybee (*Apis dorsata*) and the red dwarf honey bee (*Apis florea*). *Apis cerana* colonies are seldom sought out because the sting-to-honey gathered ratio is considered disproportionate (many stings/little honey) (Figure 41).

Figure 41: Apis cerana honey hunting.

As *Apis florea* is common in disturbed areas (urban, agricultural, secondary forest), nests of the species are harvested through the whole province of Siem Reap. Honey hunting of the forest species *Apis dorsata* (Figure 42) occurs mainly in the remaining forest areas of the province, e.g., Phnom Kulen in the dry season and Tonle Sap flooded forest in the rainy season.

Figure 42: Apis dorsata honey hunting.

Traditionally, nests are harvested in a destructive way: the entire comb is cut off as both honey and bee brood are consumed or sold. In addition, opportunistic honey hunters*, are often using fire or insecticides to avoid being stung.

* Opportunistic honey hunters have no specific experience on bees or honey collection; they take bee nests as they find them, usually while engaged in other activities.

It is difficult, based on a few interviews, to estimate the volume of wild honey collected in the Province. However, numerous corroborating testimonies confirm a strong decrease of the volume of wild honey collected from both *Apis florea* and *Apis dorsata* in the past years. This situation reflects the dramatic decline of native bees populations in the province. Honey hunters from Tbang (Bantey Srey district) reported harvesting less than 50 liters per year while they used to harvest 2 to 300 liters annually. Faced to the rarefaction of the species, Sra Khval (Bantey Srey district) *Apis florea* hunters harvest any nests they can find, even the smallest ones (less than 10 cm) (Figure 43). A seller at road 60 (Siem Reap) reported selling only a few kg of bee brood per night while she used to sell up to 100kg per night 10 years ago.

Figure 43: Native bees scarcity leads honey hunters to collect also very small nests.

Despite the rarefaction of bees, honey collection form *Apis dorsata* and *Apis florea* is still very active in the province. Hundreds of honey collectors travel the province in their search for bee nests.

In Sotr Nikum district, honey hunting is practiced wherever native bees still remain. In particular, *Apis dorsata* and *Apis florea* are intensively hunted in Khnar Pou Community Protected Forest (Figure 43). The recent increase of Apis dorsata population resulted in a dramatic intensification of honey hunting. In the past two honey seasons, Khnar Pou Community Protected Forest attracted numerous honey hunters from other districts (or provinces) in their search for bee nests. Whole nest harvest (brood and honey) is widespread among honey hunters and the use of insecticides also frequent. The Protected community forest committee seems to have the willingness to control this activity but to be overtaken by the extend of the phenomenon.

Figure 44: Apis dorsata brood harvested by a honey hunter (Trach Pok)

According to farmers interviewed, honey collection mostly involves people from outside of their communities. Only a few farmers of the visited villages are professional honey collectors: 4 in Romdeng, 2 in Trach Pok and 1 in Trapeang Trav. Nevertheless, farmers still opportunistically harvest nests of *Apis dorsata* and *Apis florea* that they come by. Farmers not familiar with honey harvesting often use particularly destructive methods such as spraying insecticides or burning the bees. Though the majority seems to neglect stingless bees, the finding of a trunk notched around the entrance of a stingless bees nest indicates that these bees are also hunted.

Rafter beekeeping

Rafter beekeeping refers to the manufacture of purpose-made nesting sites to attract migrating swarms of the Giant Asian Honeybee (*Apis dorsata*). Beekeepers place tree-poles—rafters—mimicking large tree branches, at a slight angle and low to the ground, to encourage migrating *Apis dorsata* colonies to settle on them (Figure 45). Because of the rafter's slope the bees store the majority of the honey at the upper end of the rafter resulting in a "honey head" that may be sustainably harvested with no detriment to the brood (Figure 46). As rafters are placed typically near the ground they allow easy access (little to no climbing involved) for honey harvest. This traditional practice allows beekeepers to harvest honey two or three times from the same colony per season without destroying the bees and bee combs.

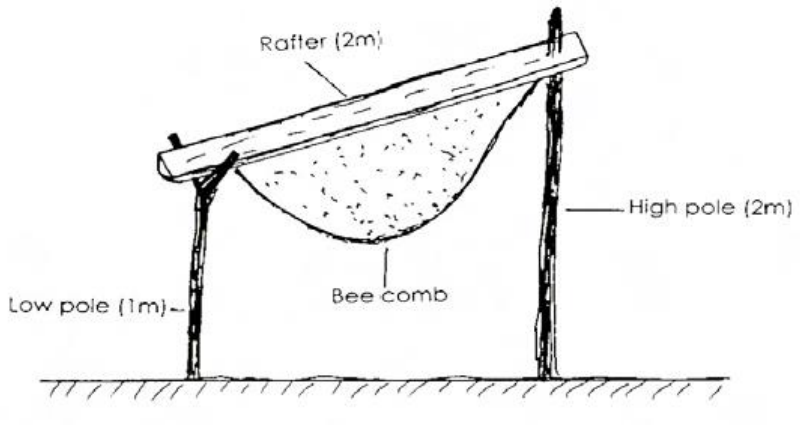

Figure 45: Rafter design. Source: Chinh P.H. et al. 1995.

Rafter beekeeping has been practiced for generations in a few villages located at the southern piedmont of the Phnom Kulen. Despite the reduction of the suitable environment (deforestation of the secondary growth forest) and the decline of local *Apis dorsata* populations, this ancestral tradition is still practiced by numerous villagers. However, honey harvests are decreasing year on year.

Figure 46: sustainable honey harvesting from a rafter (Bantey Srey district)

6.2.2 Bee farms

The western bee *Apis mellifera* was introduced in the Province a few years ago (2013). One bee farm stands at the piedmont of the Phnom Kulen (acacia and rubber tree honey) (Figure 47) and one is located on the sandstone plateau of Kulen Mountain (forest honey?).

Figure 47: Apis mellifera farm at the piedmont of the Phnom Kulen

The production of acacia and rubber honey is in the range of 4 tons per year. The production from the bee farm on the Kulen Mountain is unknown; the owner being also involved in honey trading.

Both bee farms sell their honey in several provinces included Siem Reap, Phnom Penh, Kratie, Battambang, Preah Vihear and Oddar Menchey.

Bee farm honey from Siem Reap province is commonly sold between 14$ and 20$/l (10.00$ to 14.5$/kg).

6.3 Honey trade

6.3.1 Honey quality and consumers perception

Generally speaking, in Cambodia, wild honeys have better reputation than farm honeys to which Cambodian customers attribute lower medicinal virtues and a higher risk of adulteration. As illustrated by the frequent use of the term “feeding bees” while talking about beekeeping, beekeepers are suspected (rightly or wrongly) of feeding their bees with sugar syrup during the honey season.

However, consumers’ confidence in Cambodian wild honey is also low in particular due to their fear of adulteration. Honey hunters from Trach Pok and Trapeang Trav reported a new trend among some of their customers who would only buy honey comb (kbal teuk) to avoid adulterated honey.

For some reasons, honeys that crystalize are often considered as adulterated (customers likening crystals to granulated sugar) and thus systematically rejected. However, fermentation is usually not considered as an issue.

Bee brood and wild honey are still very popular among Cambodian customers and the demand for both products is high.

Cambodian customers perception of imported honey is variable. They usually have a poor image of Chinese honeys and most of them are not aware of the difference between raw and pasteurized honeys.

6.3.2 Trading of honey produced in Siem Reap province

Wild honey and bee brood collected in the province are often sold directly by honey collectors in small booths set up along the road (Figure 48) or in local markets or their families or sold to local traders. Wild honey and bee brood are commonly sold during the day at Psar chas and Psar Leu and at road 60 at night.

Figure 48: Apis florea and Apis dorsata nests and honey on sale near Phnom Kulen.

Apis florea nests are often sold by piece, but honey is also sometimes squeezed from the comb and sold in small plastic bottles. Sold by weight, *Apis dorsata* bee brood is usually grilled in banana leaves (Figure 49). Honey is sometimes adulterated with sugar syrup.

Figure 49: Fresh and grilled Apis dorsata bee brood sold at road 60 (Siem Reap)

Bee brood is usually sold at 12.50$/kg, bee wax for 15.00$/kg and wild honey between 20.00$ and 35.00$/l (14.50$ to 25.00$/kg).

Bee products collected by honey hunters from Sotr Nikoum district are usually in the range of the market. *Apis dorsata* bee brood is sold between 6$ (Trapeang Trav) and 12.5$/kg (Trach Pok) and *Apis dorsata* honey from 10$ (Trapeang Trav) to 30$/l (Trach Pok). Prices of honey collectors from Romdeng are intermediate: 7.5$/kg (bee brood) and 25$/l (honey). Prices don't seem to reflect the quality of honey; otherwise, rainy season honeys collected in Trach Pok and Trapeang Trav should be lower than those of dry season honeys from Romdeng. Price differences are very likely more related to specific deals between collectors and traders or buyers. Honey prices in Romdeng have more than doubled between 2018 and 2019: from 10$ to 25$/l.

Farmers are usually aware of the medicinal benefits of honey (Trach Pok, Romdeng and Prum Kot).

When collected, stingless bees honey is usually consumed directly by the collector or his family (Romdeng and Prum Kot).

6.3.3 Retailers in Siem Reap

Surveys were done at 6 supermarkets (Angkor Market 1 and 2, Asia Market, Lucky Supermarket, Chao Sang Hok and Thai Huot) and 5 souvenir shops (Angkor Cookies, Bodia, Cambodia Tea Time, Senteurs d'Angkor and Svay Check Organic Farm Shop).

Generally speaking, souvenir shops sell exclusively Cambodian honeys while the majority of honeys found in supermarkets are imported.

Details of brands and prices observed are provided in Annex 1.

Souvenir shops

Souvenir shops offer two varieties of Cambodian honey for sell: *Apis dorsata* forest honey originated from different provinces of Cambodia and *Apis mellifera* acacia - rubber honey from Bantey Srey district. Prices vary from 34.50$ to 50.50$/kg for wild honey and from 27.00$ to 71.50$/kg for farm honey. Considering the average wholesale prices, these retail prices correspond to a gross margin of 100 to 190% for wild honey and 40 to 270% for farm honey.

Information related to the origins and types of Cambodian honey are often approximate and sometimes incorrect. *Apis mellifera* honey is sometimes labeled as organic or as wild honey though none of these qualifications are correct (Figure 50). Some beekeeping practices widespread in Cambodia (honey extraction from brood frames, feeding with non-organic sugar and pollen substitute, non-organic pest treatment, proximity to pesticides treated fields…) are not compliant with organic standards. *Apis dorsata* honey is sometimes promoted with a picture of *Apis mellifera*.

Figure 50: Apis mellifera honey incorrectly labeled as organic in a souvenir shop.

Supermarkets

Supermarkets offer a wide range of products. More than 55 different honeys or brands could be found in the 6 supermarkets visited (more than 85, taking into account the containers capacity).

Imported honeys are originated from the 4 corners of earth; they come from 11 different countries: Australia, Brazil, China, European Union, France, Macedonia, Malaysia, New Zealand, Thailand, UK and the USA. Surprisingly, Vietnamese honeys are absent from the shelves.

Chinese honeys are the cheapest, which is not a surprise due to quality issues (pesticide and antibiotic residues, adulteration). The cheapest Chinese honeys are sold at similar prices (less than 4.00$/kg) than products labeled as mixtures of honey and syrup (17%honey, sugar 34%, glucose syrup 39%). Beside specific raw honey with fancy packaging (30.00$ to 32.00$/kg), Thai honey are also quite cheap (5.50$ to 11.00$/kg). Australian honeys (14.00 to 16.00$/kg), honeys sold under European brands but with unclear origins (EU and non EU) (15.50$ to 19.50$/kg) and USA honeys (12.50$ to 20.50$/kg) come next.

The most expensive products are honey combs (58.00$ to 69.50$/kg) (Figure 51) and the very high priced manuka honey (a monofloral honey from New Zealand considered as having higher than normal antibacterial properties), sold between 70.00 and 94.00$/kg.

Figure 51: Honey combs in a supermarket

Similarly to souvenir shops practices, Cambodian products are sold at very variable prices, ranging between 13.25$ and 40.00$/kg.

Apart from an *Apis dorsata* Malaysian forest honey, all of the imported honeys are produced by European bees (*Apis mellifera*). Cambodian honeys sold in supermarkets are mainly forest honeys from *Apis dorsata* (Figure 52). Only one supermarket (Chao Sang Hok) also sells Cambodian honeys from *Apis mellifera* (acacia, rubber tree and kapok).

Figure 52: Cambodian Apis dorsata honeys in as supermarket

Thai and Chinese honey are very likely pasteurized and ultra-filtered to prevent fermentation and crystallization. Pasteurization destroys subtle floral esters (bouquet) and enzymes, and might produce a high content of hydroxymethylfurfural (HMF) from the thermal breakdown of the simple sugars. HMF level is a standard quality test. Ultra filtered honeys lose some of their nutrients and flavors in the process.

It is quite likely that some of the cheapest honeys are adulterated and possibly some of the expensive ones as well. Honey is the world's third most adulterated food (Zhou, Taylor, Salouros, & Prasad, 2018). In 2014, only 1,700 tons of manuka honey were produced, while more than 10,000 tons of honey labeled manuka were sold (Usborn, 2014)!

The distances travelled by some of the imported honey are quite insane: a Brazilian honey sold in Cambodia under a US brand has probably travelled from Brazil to the USA, to finally end up in Cambodia; honeys sold under a French brand with an origin labeled as "EU and non EU" may contain some Chinese honey which traveled all the way from China to France to end up in Cambodian Supermarkets.

6.3.4 Honey traders

In addition to retailers, numerous small honey traders are involved in honey business in Siem Reap. They are usually individuals using their personal contacts with beekeepers or honey collectors to buy honey and to resell it to other connections in town with variable margins. Building a trust relationship with their honey suppliers and their customers is the main challenge for these improvised traders.

6.4 Suggestions

Honey supply in the province and in Cambodia is far from covering the demand of the domestic market.

While Apis cerana and stingless bee honey are susually sold at higher prices than Apis mellifera honeys in other South East Asian countries, these high valu honeys are completely absent on Cambodian market.

There is a clear market opportunity for Apis cerana and stingless bees honeys in Cambodia and in particular in the touristic city of Siem Reap.

7. Synthese and suggestions

With rare exceptions, **farmers have very low or no knowledge on pollination** and its importance for their crop yields as well as the impact of some of their behaviors (pesticides, honey hunting…) on pollinator's communities. However, **farmers seem to be very receptive to messages related to the importance of pollinators conservation**.

Bees are involved in the pollination of 33 fruits and vegetables produced in Sotr Nikum district and their contribution is crucial for 10 of them. Local land management and farming practices (proximity of natural ecosystems, small agricultural plots surrounded by semi-natural areas…) are *a priori* favorable to pollinators and **no situation of pollination deficit** was brought to light during the focus group discussions. However, some famers behaviors (pesticides, destructive honey hunting) are obviously threatening pollinators populations.

The 4 Cambodian native honeybee species (Asian giant honeybee (*Apis dorsata*), Eastern honeybee (*Apis cerana*) and the two dwarf honeybees (*Apis florea* and *Apis andreniformis*) as well as several species of stinlgess bees are present in Sotr Nikum district. With one exception, **all the populations are in strong decline throughout the 3 bio geographical zones; the decline being more dramatic in the low land**.

Two options of sustainable beekeeping (we consider beekeeping with the introduced Western honeybee, *Apis mellifera*, as not sustainable) **are possible in Sotr Nikum district: beekeeping with the Eastern honeybee (*Apis cerana*) and meliponiculture (beekeeping with stingless bees).** While widely spread in neighboring countries (Thailand, Laos and Vietnam) and other Asian countries such as India, beekeeping with *Apis cerana* and meliponiculture are barely absent in Cambodia (only a few colonies kept in Battambang). However, both bees are great pollinators and produce **highly valuable honeys**.

The high and medium lands bio-geographical zones present the most favorable conditions for the development of beekeeping with in particular: (1) several bee plants with almost permanent blooming (coconut, sugar palm, jujube…), (2) the proximity to forests (main flower blooms from October to December and March to May) and (3) sesame plantations (2 flower blooms possible between July and October). Beekeeping in low land has a lower potential and might mainly be considered as a support to pollination as this area is very likely the most exposed to pollinators shortage.

Wild honey collection (honey hunting), mainly from the giant Asian honeybee (*Apis dorsata*) and the red dwarf honeybee (*Apis florea*), still constitutes a **significant part of honey production in Cambodia** as well as in the province of Siem Reap. Traditionally, nests are harvested in a destructive way: the entire comb is cut off as both honey and bee brood are consumed or sold, which contributes to native bees populations decline. In Sotr Nikum district, honey hunting is practiced wherever native bees still remain. In particular, *Apis dorsata* and *Apis florea* are intensively hunted in Khnar Pou Community Protected Forest. Two bee farms located in the North of Siem Reap produce a few tons of honey (mainly acacia and rubber) with the introduced Western honey bee (*Apis mellifera*).

Imported honeys (more than 50 kinds from 11 countries and 5 continents) represent a very important part of the honeys sold in supermarkets of Siem Reap. Cambodian honeys are sold through informal channels (small-scale roadside shops, local markets…) or in souvenir shops and supermarkets. Cambodian honey is a high added value product, sold between 35 and 70$/kg in retails shops. **There is a clear market opportunity for *Apis cerana* and stingless bees honeys in Cambodia and in particular in the touristic city of Siem Reap as both products are still absent from the market.**

Suggestions:

1/ Awareness campaigns on pollination and pollinators conservation. The training could cover the following topics:

- Pollination and its impact on fruits and vegetables yields;
- Pollinators agents;
- Importance of abundant and diverse pollinators communities;
- Threats on pollinator's communities (pesticides, deforestation, loss of natural ecosystems in farms vicinity, unsustainable honey hunting…);
- Practical measures to preserve/increase pollinator's populations (agro-ecology, forest conservation, conservation of (semi-)natural ecosystems around fields, sustainable honey hunting, beekeeping…).

2/ Beekeeping with *Apis cerana* and meliponiculture. The introduction of beekeeping could provide additional incomes to farmers, reinforce pollinator's communities and contribute to crops pollination, contribute restoring the local populations of native bees and contribute to the agro-ecological transition of small scale farmers through a better understanding of the challenge of pesticides uses. Beekeeping should preferentially be initiated in the villages of high and medium lands with the highest potential.

As (1) introducing a new activity to communities is always challenging, (2) the beekeeping potential of heterogenic ecosystems such as natural forests may differ from place to place, (3) honey from sugar palm has never been documented though the plant is obviously an excellent source of nectar, a pilot project should be considered as a first phase. To increase the chances of success, the pilot project should ideally be implemented in a few villages and involve a minimum numbers of farmers.

Stingless bee colonies could be sourced in Eastern Thailand. Villagers could also be trained on feral colonies and swarms capture.

Regarding *Apis cerana*, the risk of genetic contamination of local population should be assessed prior to importing colonies from Vietnam (more than 500 km and some beekeepers working with hybrids *Apis cerana cerana* x *Apis cerana indica*) or southern Thailand (more than 1000 km). In line with the precautionary principle, swarms capture should be privileged as feral colony transfer is often destructive. The project might also be an opportunity to test an artificial swarm attractant developed by Prof. Fumio Sakamoto (Kyoto Gakuen University) and his team. This lure using active components from Oriental orchid (Cymbidium floribundum) has been successfully tested on *Apis cerana japonica* in Japan and the team is interested to test it on *Apis cerana cerana* in Laos and *Apis cerana indica* in Cambodia.

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Annexes

Annex 1: Honey survey in Siem Reap retailers 09 2019

Shop	Origin	honey type	bee species	Brand	$/jar	kg/jar	$/kg
Asia Market	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 4.97	0.28	$ 17.75
Asia Market	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 9.18	0.56	$ 16.39
Asia Market	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 15.35	0.98	$ 15.66
Asia Market	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 12.55	0.5	$ 25.10
Asia Market	China		*A. mellifera*	Yowe	$ 2.95	0.45	$ 6.56
Asia Market	China		*A. mellifera*	Yowe	$ 5.35	1	$ 5.35
Asia Market	China		*A. mellifera*	Belle Pure honey	$ 4.50	1	$ 4.50
Asia Market	China		*A. mellifera*	Hosen	$ 4.75	1	$ 4.75
Asia Market	China		*A. mellifera*	Bello	$ 4.50	1	$ 4.50
Asia Market	Macedonia	wild flowers	*A. mellifera*	Vitalia	$ 8.71	0.9	$ 9.68
Asia Market	Macedonia	wild flowers	*A. mellifera*	Vitalia	$ 5.10	0.45	$ 11.33
Asia Market	Thailand		*A. mellifera*	Thai Richy	$ 13.10	0.5	$ 26.20
Asia Market	Thailand	Longan	*A. mellifera*	Thai	$ 6.70	1	$ 6.70
Asia Market	Thailand	wild honey	*A. mellifera*	Thai	$ 7.10	1	$ 7.10
Asia Market	Thailand	wild honey	*A. mellifera*	X Thai	$ 5.50	1	$ 5.50
Thai Huot	Australia	Honey floral	*A. mellifera*	Super Bee	$ 6.55	0.25	$ 26.20
Thai Huot	Australia	honey and ginger	*A. mellifera*	Super Bee	$ 7.55	0.25	$ 30.20
Thai Huot	Australia	honey and lemon	*A. mellifera*	Super Bee	$ 12.55	0.5	$ 25.10
Thai Huot	Australia	honey macadamia	*A. mellifera*	Super Bee	$ 10.20	0.5	$ 20.40
Thai Huot	Australia	iron bark honey	*A. mellifera*	Honey for Health	$ 10.20	0.5	$ 20.40
Thai Huot	Cambodia (MDK)	Forest honey	*A. dorsata*	Coffee MK Mondulkiri	$ 10.55	0.56	$ 18.84
Thai Huot	China		*A. mellifera*	Sea quality	$ 3.10	0.5	$ 6.20
Thai Huot	China		*A. mellifera*	Yowe	$ 2.80	0.45	$ 6.22
Thai Huot	China		*A. mellifera*	Yowe	$ 5.80	1	$ 5.80
Thai Huot	China		*A. mellifera*	Hosen	$ 3.40	0.5	$ 6.80
Thai Huot	China		*A. mellifera*	Hosen	$ 5.80	1	$ 5.80
Thai Huot	China		*A. mellifera*	Sea quality	$ 5.50	1	$ 5.50
Thai Huot	Thailand	honey + glucose syrup + sugar	*A. mellifera*	Imperial	$ 3.50	0.923	$ 3.79
Asia Market	Thailand	Longan	*A. mellifera*	Thai	$ 8.05	1	$ 8.05
Asia Market	Thailand	wild honey	*A. mellifera*	Thai	$ 6.85	1	$ 6.85
Thai Huot	UE and non UE	mixed flowers	*A. mellifera*	Michaud (Lune de miel)	$ 7.80	0.5	$ 15.60

Thai Huot	UE and non UE	mixed flowers organic	*A. mellifera*	Michaud (Lune de miel)	$ 9.80	0.5	$ 19.60
Thai Huot	UE and non UE	mixed flowers	*A. mellifera*	Michaud (Lune de miel)	$ 5.20	0.375	$ 13.87
Thai Huot	UE and non UE	mixed flowers organic	*A. mellifera*	Michaud (Lune de miel)	$ 5.55	0.25	$ 22.20
Angkor Market (2)	Australia	Honey floral	*A. mellifera*	Super Bee	$ 6.55	0.25	$ 26.20
Angkor Market (2)	Australia	honey and ginger	*A. mellifera*	Super Bee	$ 7.55	0.25	$ 30.20
Angkor Market (2)	Australia	honey and lemon	*A. mellifera*	Super Bee	$ 13.50	0.5	$ 27.00
Angkor Market (2)	Australia	honey macadamia	*A. mellifera*	Super Bee	$ 10.20	0.5	$ 20.40
Angkor Market (2)	Cambodia	Fresh raw honey	*A. dorsata?*	Simply natural	$ 17.20	1	$ 17.20
Angkor Market (2)	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 13.00	0.5	$ 26.00
Angkor Market (2)	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 5.50	0.2	$ 27.50
Angkor Market (2)	Cambodia (MDK)	forest	*A. dorsata*	Angkor Market	$ 6.50	0.35	$ 18.57
Angkor Market (2)	China		*A. mellifera*	Hosen	$ 5.20	1	$ 5.20
Angkor Market (2)	China		*A. mellifera*	Yowe	$ 4.50	1	$ 4.50
Angkor Market (2)	China		*A. mellifera*	Twin Valley	$ 3.95	1	$ 3.95
Angkor Market (2)	China		*A. mellifera*	Twin Valley	$ 2.30	0.45	$ 5.11
Angkor Market (2)	china		*A. mellifera*	Redman pure honey	$ 5.50	1	$ 5.50
Angkor Market (2)	China		*A. mellifera*	Hosen	$ 5.20	1	$ 5.20
Angkor Market (2)	China		*A. mellifera*	Hosen	$ 2.70	0.4	$ 6.75
Angkor Market (2)	China		*A. mellifera*	Super honey	$ 4.80	1	$ 4.80
Angkor Market (2)	China		*A. mellifera*	Super honey	$ 2.60	0.4	$ 6.50
Angkor Market (2)	China		*A. mellifera*		$ 3.50	0.7	$ 5.00
Angkor Market (2)	Macedonia	wild flowers	*A. mellifera*	Vitalia	$ 9.80	0.9	$ 10.89
Angkor Market (2)	Macedonia	wild flowers	*A. mellifera*	Vitalia	$ 5.20	0.45	$ 11.56
Angkor Market (2)	Malaysia	Wild harvest black gold honey	*A. dorsata?*	Simply natural	$ 19.70	1	$ 19.70
Angkor Market (2)	New Zealand	organic raw manuka	*A. mellifera*	woodland's	$ 47.00	0.5	$ 94.00
Angkor Market (2)	New Zealand	raw manuka	*A. mellifera*	Manuka health	$ 35.00	0.5	$ 70.00

Angkor Market (2)	Thailand	Longan	*A. mellifera*	Thai	$ 2.70	0.36	$ 7.50
Angkor Market (2)	Thailand	honey + glucose syrup + sugar	*A. mellifera*	Imperial	$ 3.50	0.923	$ 3.79
Angkor Market (2)	Thailand	honey comb	*A. mellifera*	supha bee farm	$ 5.80	0.1	$ 58.00
Angkor Market (2)	Thailand	honey comb	*A. mellifera*	supha bee farm	$ 13.90	0.2	$ 69.50
Angkor Market (2)	UK (China?)	honey	*A. mellifera*	Rowse honey	$ 5.50	0.34	$ 16.18
Angkor Market (2)	UK (China?)	organic honey	*A. mellifera*	Rowse honey	$ 5.90	0.34	$ 17.35
Angkor Market (2)	UK (China?)	honey comb in acacia honey	*A. mellifera*	Rowse honey	$ 11.50	0.34	$ 33.82
Angkor Market (2)	China		*A. mellifera*	Mc. Mahon's	$ 2.50	0.5	$ 5.00
Angkor Market (1)	Australia	rain forest	*A. mellifera*	Super Bee	$ 6.95	0.25	$ 27.80
Angkor Market (1)	Australia	Iron Black	*A. mellifera*	Super Bee	$ 6.95	0.25	$ 27.80
Angkor Market (1)	Australia	Tasmania leatherwood	*A. mellifera*	Super Bee	$ 6.95	0.5	$ 13.90
Angkor Market (1)	Australia	honey macadamia	*A. mellifera*	Super Bee	$ 6.95	0.5	$ 13.90
Angkor Market (1)	Brazil	organic raw honey		kirland (USA)	$ 7.50	0.68	$ 11.03
Angkor Market (1)	Cambodia	Fresh raw honey	*A. dorsata?*	Simply natural	$ 17.20	1	$ 17.20
Angkor Market (1)	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 18.00	0.98	$ 18.37
Angkor Market (1)	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 13.00	0.5	$ 26.00
Angkor Market (1)	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 5.50	0.2	$ 27.50
Angkor Market (1)	Cambodia (MDK)	forest	*A. dorsata*	Angkor Market	$ 6.50	0.35	$ 18.57
Angkor Market (1)	Cambodia (PV)	forest	*A. dorsata*	Bodia	$ 8.90	0.259	$ 34.36
Angkor Market (1)	China		*A. mellifera*	super Honey	$ 4.80	1	$ 4.80
Angkor Market (1)	China		*A. mellifera*	Yowe	$ 4.50	1	$ 4.50
Angkor Market (1)	China		*A. mellifera*	Hosen	$ 5.20	1	$ 5.20
Angkor Market (1)	China		*A. mellifera*	Yowe	$ 2.80	0.45	$ 6.22
Angkor Market (1)	China		*A. mellifera*	Yowe	$ 4.50	1	$ 4.50
Angkor Market (1)	China		*A. mellifera*	Twin Valley	$ 3.95	1	$ 3.95
Angkor Market (1)	China		*A. mellifera*	Twin Valley	$ 2.30	0.45	$ 5.11

Angkor Market (1)	China		*A. mellifera*	Super pure honey	$ 4.80	1	$ 4.80
Angkor Market (1)	China		*A. mellifera*	Redman pure honey	$ 5.50	1	$ 5.50
Angkor Market (1)	Macedonia	wild flowers	*A. mellifera*	Vitalia	$ 9.80	0.9	$ 10.89
Angkor Market (1)	Macedonia	wild flowers	*A. mellifera*	Vitalia	$ 5.20	0.45	$ 11.56
Angkor Market (1)	Malaysia	Wild harvest black gold honey	*A. dorsata?*	Simply natural	$ 19.70	1	$ 19.70
Angkor Market (1)	Thailand	honey comb	*A. mellifera*	supha bee farm	$ 5.80	0.1	$ 58.00
Angkor Market (1)	Thailand	honey comb	*Ap. mellifera*	supha bee farm	$ 13.90	0.2	$ 69.50
Angkor Market (1)	Thailand	honey + glucose syrup + sugar		Imperial	$ 3.50	0.923	$ 3.79
Angkor Market (1)	China		*A. mellifera*	Mc Mahon's	$ 2.50	0.5	$ 5.00
Chao Sang Hok	Cambodia	pack of 6 very small bottles	*A. mellifera*	Cambodia Lady Natural honey	$ 3.00	-	
Chao Sang Hok	Cambodia	honey comb	*A. mellifera*	Cambodia Lady Natural honey	$ 20.00	-	
Chao Sang Hok	Cambodia	blossom honey	*A. mellifera*	Cambodia Lady Natural honey	$ 30.00	1	$ 30.00
Chao Sang Hok	Cambodia	Kapok honey	*A. mellifera*	Cambodia Lady Natural honey	$ 20.00	0.5	$ 40.00
Chao Sang Hok	Cambodia	Rubber honey	*A. mellifera*	Cambodia Lady Natural honey	$ 10.00	0.25	$ 40.00
Chao Sang Hok	Cambodia	Kapok honey	*A. mellifera*	Cambodia Lady Natural honey	$ 3.50	0.15	$ 23.33
Chao Sang Hok	Cambodia	acacia honey	*A. mellifera*	-	$ 4.50	0.34	$ 13.24
Chao Sang Hok	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 12.50	0.5	$ 25.00
Chao Sang Hok	Cambodia (NE)	forest	*A. dorsata*	Save Wildlife Cambodia	$ 5.00	0.2	$ 25.00
Chao Sang Hok	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 5.00	0.28	$ 17.86
Chao Sang Hok	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 9.75	0.56	$ 17.41
Chao Sang Hok	Cambodia (MDK)	forest	*A. dorsata*	Coffee MK Mondulkiri	$ 16.80	0.98	$ 17.14
Chao Sang Hok	China		*A. mellifera*	royal miller			
Chao Sang Hok	China		*A. mellifera*	royal miller	$ 5.80	1	$ 5.80
Chao Sang Hok	China		*A. mellifera*	Hosen	$ 3.00		
Chao Sang Hok	China		*A. mellifera*	Hosen	$ 2.60	0.4	$ 6.50
Chao Sang Hok	China		*A. mellifera*	Hosen	$ 4.90	1	$ 4.90

Chao Sang Hok	China		*A. mellifera*	Super Honey	$ 2.80	0.5	$ 5.60
Chao Sang Hok	China		*A. mellifera*	Super Honey	$ 2.70	0.4	$ 6.75
Chao Sang Hok	China		*A. mellifera*	Sea Quality	$ 2.80	0.5	$ 5.60
Chao Sang Hok	China		*A. mellifera*	Sea Quality	$ 4.95	1	$ 4.95
Chao Sang Hok	China		*A. mellifera*	Yowe	$ 6.00	1	$ 6.00
Chao Sang Hok	Thailand	Longan honey	*A. mellifera*	Thai Richu	$ 10.95	1	$ 10.95
Chao Sang Hok	Thailand	Longan raw honey	*A. mellifera*	Thai Richu	$ 14.95	0.5	$ 29.90
Chao Sang Hok	Thailand	Longan honey	*A. mellifera*	Thai	$ 7.15	1	$ 7.15
Chao Sang Hok	Thailand	Longan honey	*A. mellifera*	Thai	$ 7.15	1	$ 7.15
Chao Sang Hok	Thailand	wild honey	*A. mellifera*	Thai	$ 3.45	0.36	$ 9.58
Chao Sang Hok	Thailand	Longan honey	*A. mellifera*	X Thai	$ 6.20	0.36	$ 17.22
Chao Sang Hok	Thailand	wild honey	*A. dorsata?*	X Thai	$ 3.95	0.375	$ 10.53
Lucky supermarket	Australia	Australian Honey	*A. mellifera*	Sun Harvest	$ 7.90	0.5	$ 15.80
Lucky supermarket	Brazil	organic raw honey	*A. mellifera*	Kirkland	$ 11.80	2.27	$ 5.20
Lucky supermarket	china	Honey	*A. mellifera*	Quand Sheng Yuan	$ 5.00	0.5	$ 10.00
Lucky supermarket	China	Honey	*A. mellifera*	Hosen	$ 3.70	0.4	$ 9.25
Lucky supermarket	China	Honey	*A. mellifera*	Hosen	$ 3.95	0.5	$ 7.90
Lucky supermarket	France	flower honey	*A. mellifera*	Casino	$ 4.50	0.25	$ 18.00
Lucky supermarket	France	Mountain honey	*A. mellifera*	Casino	$ 9.90	0.5	$ 19.80
Lucky supermarket	Indonesia	honey substitute		Tropicana slim	$ 6.80	0.525	$ 12.95
Lucky supermarket	Thailand	Longan raw honey	*A. mellifera*	Thai Richu	$ 16.20	0.5	$ 32.40
Lucky supermarket	Thailand	wild raw honey	*A. mellifera*	Thai Richu	$ 16.20	0.5	$ 32.40
Lucky supermarket	Thailand	honey flavored syrup	*A. mellifera*	Imperial	$ 4.25	0.67	$ 6.34
Lucky supermarket	Thailand	Longan honey	*A. mellifera*	Thai	$ 8.00	1	$ 8.00
Lucky supermarket	Thailand	Longan honey	*A. mellifera*	Thai	$ 3.60	0.36	$ 10.00
Lucky supermarket	Thailand	wild honey	*A. mellifera*	Thai	$ 3.60	0.36	$ 10.00

Lucky supermarket	USA	clover honey	*A. mellifera*	sue Bee	$ 28.90	2.3	$ 12.57
Lucky supermarket	USA	clover honey	*A. mellifera*	sue Bee	$ 12.50	0.68	$ 18.38
Lucky supermarket	USA	clover honey	*A. mellifera*	sue Bee	$ 6.95	0.34	$ 20.44
Lucky supermarket	USA	clover honey	*A. mellifera*	Kirkland	$ 29.00	0.68	$ 42.65
Lucky supermarket	USA	raw unfiltered clover honey	*A. mellifera*	Aunt Sue's	$ 11.90	0.68	$ 17.50
Lucky supermarket	USA	raw unfiltered wild flowers honey	*A. mellifera*	Aunt Sue's	$ 8.50	0.454	$ 18.72
Bodia	Preah Vihear	forest	*A. dorsata*	Bodia	$ 8.90	0.259	$ 34.36
Angkor cookies	Siem Reap?	forest	*A. dorsata*	Cedac	$ 12.65	0.25	$ 50.60
Cambodia Tea Time	Siem Reap	Acacia	*A. mellifera*	Khmer Beekeeping	$ 10.00	0.14	$ 71.43
Cambodia Tea Time	Siem Reap	Acacia	*A. mellifera*	Khmer Beekeeping	$ 5.00	0.07	$ 71.43
Senteur d'Angkor	Siem Reap	Acacia	*A. mellifera*	Khmer Beekeeping	$ 7.00	0.14	$ 50.00
Senteur d'Angkor	Siem Reap	Acacia	*A. mellifera*	Khmer Beekeeping	$ 3.00	0.045	$ 66.67
Svay Check Organic farm	Siem Reap	Acacia	*A. mellifera*	Khmer Beekeeping	$ 5.78	0.2	$ 28.90
Svay Check Organic farm	Siem Reap	Acacia	*A. mellifera*	Khmer Beekeeping	$ 13.58	0.5	$ 27.16