Development of beekeeping in LAOS:
Various strategic choices

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Summary

In a favourable agro-ecological and socio-economical context, the development of beekeeping in Laos faces an important strategic choice: the introduction of the exogenous species *Apis mellifera* or the slow development of the actual beekeeping with endogenous species *Apis cerana* and *Trigona laeviceps*.

Should Laos favour the development of a beekeeping activity with 'modern' technology and the introduction of *Apis mellifera*, in the image of what has been done in Thailand and other neighbouring countries that have a competitive beekeeping, the beekeepers will have to bear numerous risks. Economical risks linked to important investment charges; pathological risks due to the high sensitivity of *Apis mellifera* to pests and bacteria; genetic risks engendered by the introduction of new genetic material and marketing risks resulting in the necessity to feed colonies with large quantities of sugar, whose market price fluctuates. Those farming systems specialized in beekeeping would face highly competitive beekeeping systems in neighbouring countries. These new actors would be economically weak.

On the other hand, should Laos favour the development of beekeeping based on the endogenous species, *Apis cerana* and *Trigona laeviceps*, this will give the Lao farmers the possibility to diversify their activities and to strengthen their farming systems. This policy would involve a strong support regarding:

- The extension of beekeeping practices suitable to the context of each province;
- The research and the improvement of the local breed permitting efficient beekeeping (low absconding and swarming breeds).

Moreover this policy would permit the Laotian provinces to highlight their comparative advantage whether it is the importance of the primary forest, or the richness of the melliferous flora and fauna and to take advantage of interesting marketing niches in the country (forest honey, medicinal honey, Phongsaly honey) and outside (quality honey, organic honey permitting to create PGI - Protected Geographical Indication).

Acronyms and definitions

FAO: Food and Agricultural Organization of the United Nation
FOA: Faculty of Agriculture – Campus of Nabong – National University of Laos
Kip: Official currency of Laos. In 2005, 1 USD was worth 9600 Kips
In 2004, the exchange rate of the kip fluctuated between 9500 and 10700 kip for 1 USD
NTFP: Non Timber Forest Products
Ray: 1600 square meter (40 m * 40 m)
USD: US Dollars

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Although several bordering countries (China, Vietnam, Thailand) developed a powerful exporting beekeeping, Laos and in particular the inhabitants of the plain of Vientiane produce and consume a honey mainly resulting from the destructive collection of the colonies of *Apis cerana* and *Apis dorsata*.

This report is all the more astonishing as the weather and topographic conditions are close to those of the nearby countries having a long apiarian tradition. Moreover, Laos has a faunistic and floristic richness particularly favourable to beekeeping.

However, beekeeping remains exceptional there.

An agro-ecological and socio-economical context favourable to beekeeping

The Apis genus counts nine species of bees. The genetic and morphological characteristics of these social insects make it possible to gather them in 4 groups. One of these groups, constituted by the species *A. mellifera* and its numerous subspecies, populated originally the European and African continents, before being scattered by human being on the other continents.

In Asia, an important apiarian fauna

The three other groups *Apis dorsata*, *Apis florea* and *Apis cerana* are distributed in Asia

The first species called 'giant bee' because of the size of its workers (16 mm) is close to its ancestor 'Synapis' who took refuge in the south of Asia during the cooling of the end of the tertiary era. The colonies of *Apis dorsata* build a single comb of great dimension (50 cm to 1m) placed outdoors, hung on branches of trees, under steep cliffs or even under buildings of big dimension.

Photo 1 Colonies of bees *Apis dorsata*

The dwarf bee, *Apis florea* is present in the same geographical sector. Its ecological niche is constituted of the stratum of shrubs with dense foliage.

Photo 2 Colony of bees *Apis florea*

Finally the colonies *Apis cerana*, the behaviour of which is close to *Apis mellifera*, build their nests, made up of several parallel combs, in closed spaces. Just like the European bee, this species developed a strategy of social thermoregulation. These bees, thus, manage to resist strong thermal amplitudes (- 30°c to +40°c) and were able to colonize a more important geographic area, from the southeast of Russia and China, to the extremely south of Asia (VANDAME R., 1996).

Photo 3 Swarm of bees *Apis cerana* - Apiary of the Faculty of agriculture of Laos, campus of Nabong

These three species are present in Laos and give place to the picking of the honey that generally involves the destruction of the swarms.

In addition, several species of bees of the Trigona genus also exist in Laos. It is a genus of the Meliponini tribe. These bees, which also live in closed spaces, prove to be excellent pollinators, which could present an interest in the zones of fruit growing.

Important and varied natural resources

This specific importance of the genus Apis and Trigona in Laos is coupled with a remarkable flora. The abundance of the forests of primary and secondary settlement, the numerous fallow lands bound to the existence of the « slash and burn » systems and the recent appearance of important fruit orchards give to Laos a great wealth in plants producing nectar and/or pollen and in environments convenient to the installation of bees.

The abundance and the diversity of the vegetable formations and the juxtaposition of fruit growing in a wet tropical climate involve a spreading out of flowerings[1], limiting the periods of food shortage in nectar and/or pollen. These conditions give to Laos a strong apiarian potential.

An enclosing of the country implying the production of products with high added value

Laos, enclosed in the heart of the Indo-Chinese peninsula, is constituted of mountains that recover more than two thirds of the country. The road infrastructures are little developed and in a state of important degradation because of the technical difficulties and the costs of their maintenance.

The topography and the state of the road network constitute obstacles in the communication, in the transport and in the access to the markets. These aspects plead in favour of farm products with strong added value by unit of weight and volume.

Thus, some of the NTFP (Non Timber Forest Products) obtained in Laos, and in particular forest honeys, have a natural advantage.

Niche markets

A market research led in the prefecture of Vientiane by a team of teachers and students of the Faculty of Agriculture of Nabong (National University of Laos) showed the existence of a niche market for honeys of Lao origin. Indeed, many consumers originating in the country seek a wild honey (honey of forest) for its medicinal characteristics (cf. table 1). They do not wish to substitute this natural product with imported honeys, which they consider of worse quality, even if they can be supplied only during the months following the harvest, between April and June.

There is a potential for the development of this market, mainly during the periods when there is a shortage in this « natural honey ». That would require storing the product, which would imply a greater control of different parameters (packaging, humidity) that will be evoked later on.

[1] Cf. Calendar of flowering of the flora in the vicinity of the Faculty of agriculture - campus of Nabong, Prefecture of Vientiane (annex 1) and near Oudomxay (Table 6 page 28).

Result of a study of the offer and demand for honey in the prefecture of Vientiane

This study of supply (qualitative study near honey salesmen) and of demand (quantitative study near 179 consumers) made it possible to underline important aspects of supply and demand of honey in Laos. These results should be supplemented by similar exercises carried out in the suburb of the prefecture of Vientiane and in the Provinces.

Offer:
Concerning the honey, 2 major points of sale were identified: markets and mini-markets. In the large markets of Vientiane (Thalad Sao, Thalad Kwa Ding, Thalad That Luang and Thalad Thong Khan Kham), several salesmen offer apiarian products:

- **Gathered honey, produced by the "giant bees" *Apis dorsata***
  Liquid honey, moisture very often higher than 25%
  Many impurities
  Packaging: bottles of 1 L, no label
  Price ranging between 10.000 and 20.000 kips per bottle

- **Gathered honeycombs, produced by the "giant bees" *Apis dorsata***
  Liquid honey, moisture very often higher than 25%
  Many impurities
  Packaging: combs
  Price ranging between 10.000 and 20.000 kips per kg

19 mini-markets were also consulted within the framework of this study. The majority of these stores offer honeys of 2 different origins:

- **Honey of the local bee *Apis cerana*, produced by the beekeepers of various provinces of Laos**
  Liquid honey, moisture ranging between 21 and 25%
  Packaging: bottles of 1 L, no label
  Price: 20.000 kip per bottle
  Irregular provisioning: mainly during harvest (April at June)

- **Honey of the European bee Apis will mellifera, coming from Thailand**
  Liquid honey, moisture ranging between 20 and 22%,
  Micro-filtered honey, stable (no fermentation)
  Packaging: small bottles or pots with labels
  Price: 40.000 kips/pot of 500 G
  Regular provisioning

Demand:
Among the 179 consumers met:

- **43% include honey in their food;**

- **46% use honey at medicinal ends. Honey is then consumed either directly as a medicine or used to produce a medicine.**

- **Nearly 80% consider that the factors related to the intrinsic quality of the product are important (quality 80%, Origin of honey 81%, Purity 80%).**

- **Packaging and possibility of storage are also considered important for respectively 55% and 76% of the consumers.**

- **The price and the place of sales: only 28% and 19% of the consumers attach importance to this factor.**

These results were obtained following the realization of surveys carried out by Mr. Bothsakone Inthalantsee and Mr. Khamwhan Thilavong in 2003, within the framework of a training course of end of study supervised by Mr. Bounpheng Sengngam (Faculty of agriculture, Campus of Nabong, LAOS, 2003).

Table 1 Study of the market of honey in the prefecture of Vientiane.

At the level of the international markets, honeys produced in Laos cannot answer the qualitative and quantitative requirements asked by the buying groups which choose to be supplied, for the bulk products, near other countries having structured apiarian organizations since much longer or / and having access to the sea.

On the other hand, several niche markets (organic honey, honey of characteristic species) are promising and would allow Laos to advance some of its comparative advantages as the importance of the primary forest, the wealth of the flora and the apiarian fauna and so to market "honeys obtained in area of primary forests", "honeys of *Apis cerana*", "honeys of Trigona" for example.

Current apiarian practices

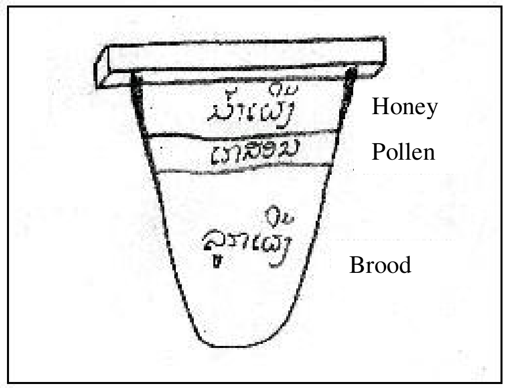
Available honeys in the markets of Laos are mainly honeys of picking and honeys resulting from small-scale beekeeping.

Honey hunting

The collection of honey of the wild colonies seems to be practiced for a long time. It consists in removing combs (cf. table 2) from the colony, to extract from it honey, the larvae of bees, pollen and wax.

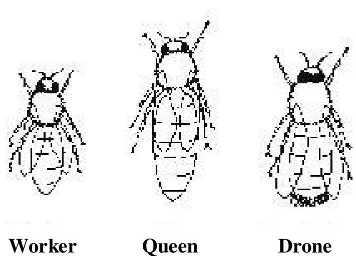
What is a colony?

A colony is formed by several parallel combs on which we find, honey, pollen and brood (eggs - larvae - pupae).



In the colony several castes of bees exist in several stages of

Various castes



Different stages

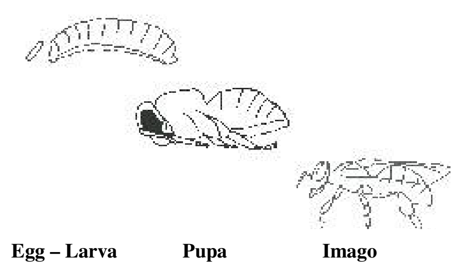


Table 2 A colony of bees *Apis cerana*

A destructive practice…

Once detached, these combs cannot be replaced in the hive, because of the absence of adequate supports. The beekeeper is generally brought to harvest the majority, even the totality of combs.

The stress caused by this "plundering" very often involves the departure of the bees and their queen. In this case, the colony is weakened.

If the harvest results in the death of the queen, the orphan colony will be condemned. This practice thus leads either to a decline of the concerned colonies which are, due to this fact, more sensitive to predators' attacks and to climatic risks, or to disappearance of these colonies and thus of their potential of natural swarming.

Near the towns, the pressure of this practice on apiarian fauna is big and lead to a fast disappearance of the colonies.

… Implying the presence of a forest space allowing the swarms to regenerate

In areas with weak density of human population, forest spaces constitute habitats favourable to the development of the swarms of bees. A balance is established between on one hand the importance of the natural swarming and on the other hand the pressure exercised by the predators and the honey gatherers.

Beekeeping in Laos

The forests are also favourable to small-scale beekeepers that try to develop in several provinces of Laos.

Thus for example, in the provinces of Oudomxay and Phongsaly, some of the farmers have traditional hives (between 1 and 20) made up of hollow tree trunks, then sealed at the two ends and populated with colonies of bees of the species *Apis cerana*.

Photo 4 Hives of the province of Phongsaly, constituted by of hollow tree trunks or stumps

Every year at the end of the rainy season, the hives are coated with materials rich in mineral elements, attractive for bees (mud, ashes, cattle dung). These substances allow sealing the openings.

The prepared hives are laid out in the neighbouring forests until they become populated.
Once populated, these hives are moved near houses. They will allow realizing one or two harvests in the season.

Beekeeping without major inputs

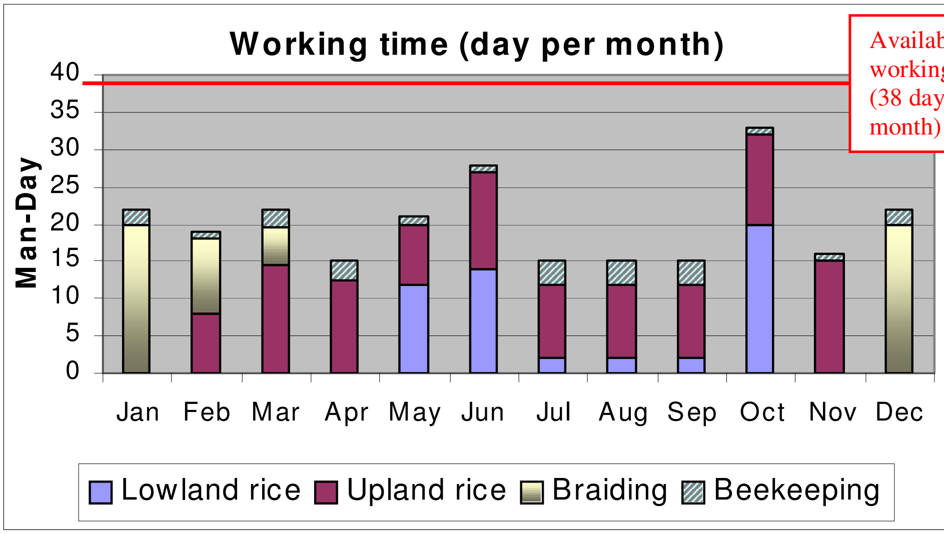
One of the characteristics of these apiarian systems is their simplicity. Except a hive built from hollow trunks and the working time devoted by the beekeeper to the hives, few inputs are necessary. The native bees (*Apis cerana*) co-evolved with their parasites and are thus tolerant with the mites and other parasites met in Laos. The absence of essential chemical treatment, the capacity of these bees to be spread out and the leniency of the climate of the various provinces of Laos are as many elements that limit the risks taken by the beekeepers in the exercise of their art.
In the worst of the cases, if desertion there is, the beekeeper always has the possibility of constituting a new livestock in a very short time, because of the importance and of the wealth of the forest place settings of Laos.

An activity implying little workforce

The study of the production systems integrating an apiarian unit, in villages of the province of Oudomxay, allowed calculating the working time necessary to the apiarian activity. Thus in the case of a farmer of the village of Phon Saat, the follow-up and the maintenance of an apiary of 12 hives implies 26 working days per annum (cf. Table 3).

Result of an inquiry with a farmer having an apiarian unit:

The production system consists of 2 rice systems (6 and 3 ray i.e. 1 and ½ hectare), a unit of braiding grasses *Imperata cylindrica* and an apiarian unit. Concerning the working time, there is a complementarity between the 4 systems. The working times of the systems braiding and beekeeping are not fixed in the year and are arranged for the periods of hollow time.



These results were obtained following the realization of surveys carried out by Mr. Bothsakone Inthalantsee in 2003, within the framework of a training practice at the of the study period, supervised by Mr. Bounpheng Sengngam (Faculty of agriculture, Campus of Nabong, LAOS, 2003).

Table 3 Work schedule of an exploitation having an apiarian unit of 12 hives

In this system of production, the apiarian activity does not present a workload peak. Only the periods December-January and March-April present a light extra work for the placement of the hives in the forest place settings (approximately 8 days between November and December) and the extraction of honey. Such a work schedule makes it possible to the farmers concerned to preserve at identical their other breeding and farming systems (Faculty of agriculture, campus of Nabong, LAOS, 2003).

The products of honey hunting and beekeeping in Lao PDR: fragile and unstable honeys

The products resulting from the gathering of honey from wild swarms (*Apis dorsata*, *Apis cerana*) and of small-scale beekeeping with *Apis cerana* allow the supply of the main markets of the capital in a product of variable and fragile quality because of its high moisture content and generally not hermetic modes of packaging.

An analysis of 30 samples of honey coming from the 3 principal markets of the Prefecture of Vientiane highlighted a strong water content (average: 22,8%) explaining the instability of the products. The honey is a perishable product. A moisture content superior to 20 % allows microorganisms and in particular yeasts to develop, involving a process of alcoholic fermentation[2].

[2] Under the activity of yeasts, the glucose and the fructose of the honey are transformed into ethanol
$C_6H_{12}O_6 \rightarrow 2\ CH_3CH_2OH + 2\ CO_2$ + energy

It is frequent to find on the shelves of the mini-markets of the Prefecture of Vientiane honeys showing an advanced stage of fermentation.

Photo 5 Honey of the province of Samneua which began to ferment

Among the 30 samples of honey, only four contained less than 20 % of water guaranteeing them a great stability. Seven samples stated moisture content lower than 21 %, thus respecting the criteria of the standard on the honey of the Codex Alimentarius.[3]

Humidity	Case	Percentage
<=20 %	3	10 %
] 20%, 21 %]	3	10 %
] 21%, 22 %]	12	40 %
] 22%, 25 %]	7	23 %
] 25%, 29 %]	3	10 %
>= 29 %	2	7 %

Table 4 Results of a study of the physicochemical characteristics of 30 honey samples of origin Lao. Faculty of agriculture, campus of Nabong, LAOS, 2004

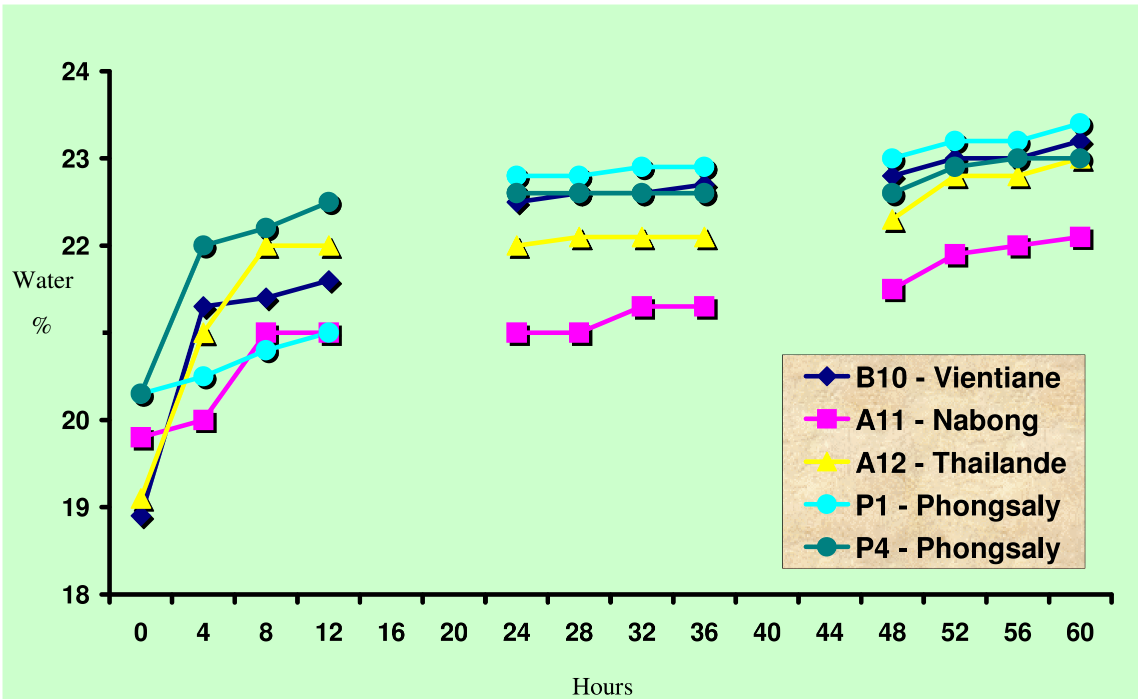
Two hypotheses can be emitted to explain this situation.
On one hand, during the picking of the honey of a wild swarm, one or several combs containing broods, pollen and honey are systematically harvested. The comb, once

[3] The Commission of the Codex Alimentarius was created in 1963 by the FAO and the OMS to elaborate food standards. The main purposes of this program are the protection of the health of the consumers, the promotion of loyal practices in the business of food and the coordination of all the works of normalization concerning food realized by organizations so governmental as not governmental. (Cf. www.codexalimentarius.net/web/index_fr.jsp).

The Standard on the honey of the Codex Alimentarius gives a definition and a description of the honey and fixes specific quality criteria such as the moisture content (> = 20 %), rate in reducing sugars (> = 60 g / 100g), in saccharose (< = 5g / 100g), in insoluble substances in the water, in HMF, the sourness (Cf. www.codexalimentarius.net /download/standards/310/CXS_012e.pdf) removed from its support, cannot be put back in place. It will be pressed, with the other combs, to extract honeys, which are at various stages of maturity. It is not technically possible to separate them.

On the other hand, the fructose is very hygroscopic. Its content in the honey is generally superior to that of the glucose (HUCHET E. and al, on 1996). It provokes a fast increase of the moisture content of honeys placed in the contact of a wet atmosphere, as it is the case of the subtropical countries (Cf. Table 5).

Result of an experimentation on the evolution of the water content of 5 honeys coming from Laos and Thailand, placed in contact with a wet atmosphere, close to 80% of hygroscopy. In average, the water content of these honeys is passed from 20 % at the beginning of the experimentation to 21.6 % after 12 hours, 22.2 % after 24 hours and 23 % after 60 hours of manipulation.



These results were obtained within the framework of a study on the physical and chemical characteristics of 30 samples of honeys of Lao and Thai origin, realized in 2004 by Mr. Phetsamone Damlong, trainee (Faculty of agriculture, campus of Nabong, LAOS, 2004)

Table 5 Moistening of honeys of Lao and Thai origin, in the contact of a wet atmosphere

The constraints of beekeeping with *Apis cerana* in traditional hives

Desertion of bees

Apis cerana and more generally the tropical species of honey bees [*Apis mellifera scutellata* in the East of the African continent and *Apis mellifera adansonii* in the West of Africa] developed a capacity to flee their habitat in the case of a too important pressure of the parasites, the predators or the climatic or hygienic constraints unfavourable with the homeostasis of the swarm.

The process of desertion engendered by these environmental constraints is widely amplified by the type of hive and the techniques of harvest. As previously announced, a harvest of the completeness of combs is a stress causing systematically the desertion.

Extraction of the honey

Another constraint is the quality of honeys obtained. These honeys are generally extracted by pressure of the harvested combs, without taking into account the degree of maturity of the honey. The traditional hives do not offer the possibility to the beekeeper to extract combs, to observe them and to reinstall them in the hive. Once taken down of its support, the comb is necessarily used by the beekeeper and thus very often pressed to extract the honey from it.

Thus honey still rich in water and sucrose (major component of nectars) is mixed with mature honey (sealed by the bees).

Moreover, in the absence of sufficiently fine filtration, numerous foreign bodies likely to carry yeasts are found in a honey whose high water content constitutes a medium favourable for their development. Quickly, the honey is going to enter a process of alcoholic fermentation[4].

Conditioning the honey

[4] « The honey which ferments releases CO_2 bubbles; its surface is raised, its taste changes; it is not marketable any more. Its only use, after destruction of ferments by heater, is industrial, possibly: manufacture of candies, cakes, gingerbread». (PROST P. J., 1987)

Photo 6 Honey of the province of Phongsaly packaged in a bottle of glass sealed by a rudimentary plastic cork

The alcoholic fermentation is all the more important as the environment allows:

- Nor treatments by the heat to destroy yeasts (by pasteurization for example), because of the absence of adequate material;
- Nor a dehumidification before extraction. The relative humidity of the air should not exceed 55 % to do it, which is not the case in period of harvest;
- Nor, finally, a control of the temperature of the places of storage of honey[5].

On the contrary, the honey, rich in fructose, has a strong hygroscopic power which thus makes it very sensitive to the process of moistening when it is in contact with an atmosphere whose relative humidity is high.

The rate of humidity of the atmosphere, often relatively high during the extraction, is further increased when:

- The delay extraction - packaging lengthens;
- The chosen packaging is not hermetic. It is often so. In Laos, the honey is packaged in glass bottles sealed by corks of paper, plastic or by metal capsules not equipped with seal.

[5] « Only a temperature of 25°c prevents the transformations of the honey». (PROST J.P., 1987)

The development of beekeeping in Lao PDR: various strategic choices

The development of beekeeping by the introduction of *Apis mellifera*, a risky solution

The numerous constraints such as the frequency of the desertion of the colonies of *Apis cerana* or the insufficient quality of honey obtained by gathering or beekeeping, discouraged many beekeepers.

Some people, attracted by the results shown by beekeeping groups and co-operatives of Thailand and Vietnam, tried to develop or wished to launch beekeeping on a greater scale by means of the introduction of the European species *Apis mellifera*.
However, this Beekeeping known as "modern" presents many disadvantages. It is likely to threaten the endemic apiarian livestock in Laos and by recurrence the beekeepers and the systems of production, which they set up gradually. Furthermore, Beekeeping with *Apis mellifera* implies the use of an advanced and expensive technology that can be made profitable only by the specialization of the systems of production and by the flow of important quantity of honey.

A risk to modify the balance of the species

During the first half of the 20th century several attempts to introduce *Apis mellifera* in geographic zones of South Asia were undertaken, modifying the balance of the settlement of indigenous species *A. cerana*, *A. florea*, *A. dorsata*, established during many millennia.

The decrease of the number of colonies of *Apis cerana* following the introduction of *Apis mellifera* was indicated, repeatedly. Thus, in Nepal, the introduction of the European bee and the modifications of the flora consecutive to the agricultural intensification exercised such a pressure on the native species *Apis cerana* that it was close to extinction (ICIMOD, 2002).

Several authors noted this same phenomenon of reduction in the population of *Apis cerana* on levels creating fear of the extinction of the species, in India and China (Respectively REDDY M.S., 1999 - Ge et al., 2000), before the species adapts itself to the new situations and allow a redeployment of their area of presence. Previously, a similar observation had been made in Japan, during the introduction of *Apis mellifera* (FAO, 1986).

An assumption advanced to explain this pressure on *A. cerana* would be related to the disorder of the mating: the queens of *A. cerana* would not always manage to mate when the males of *A. mellifera* were numerous (RUTTNER et al., 1972, 1973).
Sex hormones secreted by the queens of the various species are similar. The presence of many males of various species could prevent the male of a species from approaching a queen of the same species, limiting the possibilities of intraspecific mating. (FAO, 1986).

Let us state that the interspecific hybrids are not viable. Intrumental insemination inter-species allow the egg fecundation. However at the stage of the blastoderm, the embryonic development stops and the zygote disintegrates (RUTTNER F. and MAUL V., 1983).

This interspecific competition and the induced interferences take place only in the sectors where *A. mellifera* and *A. cerana coexist*. In the case of the endogenous species (*A. cerana*, *A. florea*, *A. dorsata*), this phenomenon does not exist. It would seem that the mating flights take place at periods, specific to the species (N. MUZAFFAR and R. AHMAD, 1988)

In addition to these risks related to the disorders of the mating between males and queens of the same species, the introduction of *A. mellifera* generates three additional risks of food, genetic and pathological nature.

A risk of food competition

One of the factors affecting the co-existence of *A. cerana* and other species of the Apis genus in the same area is the food competition. This one is reduced between the native species of Southeast Asia, which adapted each one to certain groups of flowers. Thus the bees of the Dorsata species would prefer the large flowers which produce great quantities of nectar and pollen, those of the Cerana species would visit the flowers of intermediate size, whereas those of the Florea species can collect pollen and nectar of flowers of very small dimensions. These last have been observed in habitats where other species cannot exist.

The introduced bees (*A. mellifera*) explore the same type of flowers as *A. cerana*, thus instigating food competition between these two species (KOENIGER NR. and VORWOHL G., 1979).

Genetic risks

On a genetic level, it must be announced that any introduction of genetic material can have unexpected effects, sometimes undesirable. Thus for example, in 1956, the importation of queens of a subspecies of equatorial Africa, *Apis mellifera scutellata*, in the State of Sao Paulo, Brazil, led to hybridization between these bees of African origin and the colonies present in this State.

Africanized bees (AHB), result of the crossing, appeared very aggressive. After a remarkable adaptation to the climatic conditions of the sub-continent, the AHB quickly colonized the majority of the countries of South America and Central America.

In spite of the installation, by the USDA, of a campaign against the progression of the Africanized Honey Bees in Mexico, the hybrid colonies continued their progression towards North America, reaching the United States in 1993 (DIETZ et al., 1995).

Thus in the space of half a century, the Africanized Honey Bees would have conquered more than 30 million km^2, disseminating in many countries of the American continent a very aggressive phenotype. This fast colonization was often accompanied with an increased brittleness of the European colonies rose before in some of the colonized countries.

Pathological risks

The accidental dissemination of diseases and parasites of *Apis mellifera* is the fourth risk taken during the introduction of the European bee. This risk is not negligible, 13 viruses could be isolated on colonies *A. mellifera* L. against 3 on *A. cerana* (ANDERSON D.L., 1995). Moreover, the sensibility of the species is not identical. Thus, for example, Sacbrood disease, frequent parasites of A. mellifera, was discovered on *A. cerana* in 1971 in the province of Guandong in China. This disease was quickly propagated in the provinces of Yunan, Sichuan, Fujian, Jiangxi and Anhui, causing many losses of colonies of *Apis cerana* (FANG Y., 1995). In an identical way, 90% of the colonies of *A. cerana* of Karnataka (State of the South of the Indian sub-continent) would have been destroyed by this virus during years 1990 (FAO, 1997).

Also, further to the introduction of *Apis mellifera*, the bacteria that causes European foulbrood appeared on colonies of *A. cerana* in the South-east of China in 1962 (FANG Y., 1995), in Thailand (WONGSIRI S., 1989), in Nepal, involving losses of colonies causing fear for the survival of the species (AHMAD F. et al., 2002). It should be noted that the bacterium *Melissococcus pluto*, agent of the European foulbrood, was also detected on colonies of *Apis laboriosa* (Al et al., 1990).

The introduction of *A. mellifera* constitutes a risk of dissemination of new pathologies to the native bees.
Also, *Apis mellifera* do not appear 'armed' to fight against the big predator insects (wasps, hornets, ants) frequent in the intertropical biotopes. On their side the indigenous bees have recourse to techniques of intimidation (cf. infra), which enable them to reduce the effects of the predation.
Moreover, the bees of *Apis mellifera* species, contrary to those of the endemic species, are not tolerant to the mite *Varroa destructor*. This mite which, originally, lived as a parasite on the colonies *Apis cerana* of Southeast Asia appeared on colonies of *Apis mellifera* at the end of the 19 60s with the favour of a jump inter-species. Very quickly, *V. destructor* propagated on the completeness of the colonies of Europe and America.

Today, this parasite requires an annual and systematic chemical treatment of *Apis mellifera* colonies. In the absence of treatment, the parasite exerts such a pressure on the bees of European origin that the colonies weaken. It is frequent to see bees of small dimensions or distorted, incompetent to participate in the life of the colony. In a very short time (2-3 years), the colony dies.

Specific characteristics, such as, for example, the behaviour of cleaning of the infected brood, tend to decrease the virulence of *Varroa destructor* on *Apis cerana*.

This hygienic behaviour would also explain the slightest importance of the American foulbrood within the Asian species, whereas it is a parasite whose incidence is very important within colonies and apiaries of *Apis mellifera*. (DOG Y. - W., WANQ C. - H., and Al 2000).

Economic risks

This sensibility of *Apis mellifera* to the predators and the parasites implies to proceed to attentive and regular monitoring and, if necessary, to intervene to limit the incidence of the parasitism and the predation[6].

Beside the chemical treatments often necessary to slow down the parasitic developments, it is also necessary to feed the colonies during the periods of food shortages. The colonies of *Apis mellifera*, less adapted to the climatic conditions of Southeast Asia than the colonies of *Apis cerana*, are also more sensitive to the periods of nectar and pollen scarcity.

Feeding bees requires the beekeepers working with *A. mellifera* to be supplied with sugar. This dependence induces a sensitivity of the beekeepers to the interior price of sugar. It is an additional fragility of this type of beekeeping production system. (RATIA G., 1997).

These new financial expenses are added with the investment implied by beekeeping with *A. mellifera*:

- For the acquisition of the genetic material since this European bee cannot be taken in the natural environment;
- For the construction of standardized hives allowing the storage of important quantities of honey produced by these powerful bees;
- For the purchase of equipment of extraction, maturation, storage and packaging in order to be able to collect the great quantities of honey obtained and to put them on the market under good conditions;
- For the purchase of means of transport for hives transportation and to reach markets and buy inputs.

Gradually, these increased investments and requirements in time, necessary to the monitoring of these bees sensitive to the numerous predators of the tropical zones, are going to imply a specialization of the systems of production of the concerned farmers.

To make these investments profitable, these farmers will be obliged to increase the size of their systems, implying an important requirement in financing and working capital. This news and important financial expenses will limit the economic performance of the apiarian systems of production.

[6] For example, veterinary treatments carried out by bee-keepers in France, to fight against the many parasites and diseases of *Apis mellifera*, involve costs of more than 0.5 euros per colony.
It is also necessary to add the cost of feeding which rise on average to 2.5 euros per colony. These two costs represent 5% of the gross product given by a colony (PASSOT S., 2000).

Thus, a technical-economic study carried out in 1988 with the beekeepers of the program PROSHIKA in Bangladesh, showed that the honey production obtained by apiaries using European bees were not profitable during the first four years of activity. The interests burdened the profitability of these production units with the loans contracted to acquire the equipment necessary to the production of honey with *A. mellifera*. (SVENSSON B., 1995).

The development of beekeeping with *Apis cerana*: a choice allowing to take advantage of the potential of the country

If, about fifty years after their introduction, the European bees give good results in Thailand, it should be stressed that the efforts of acclimatization were many and expensive. Thus, of the first attempt of introduction of the European bee within the campus of Kasetsart University in 1950, there remained nothing 10 years after (WONGSIRI S., 1989). It is likely that the attempts of introduction in Laos would undergo the same difficulties.

Rather than take the risks of the introduction of *A. mellifera*, it would seem more judicious to support the development of beekeeping with *Apis cerana*, with the image of what was undertaken in Sri Lanka (PUNCHIHEWA R.W.K., 1994).

This alternative would have in addition the merit to accompany the majority of the farmers of Laos in their strategy centered on food security through the diversification of the activities and thus of the incomes.

To support and reinforce small-scale beekeeping which exists in several provinces of Laos, it would be advisable to undertake work combining the study of beekeeping know-how in the provinces, the search for simple techniques of improvement of beekeeping as well as products obtained and the extension of these techniques near the beekeepers and interested village communities. In longer term, this work of promotion of beekeeping could be completed by the research and the selection of colonies for which the frequency of swarming and desertion is lesser.

Existence of a know-how in various provinces

Numerous villagers of the provinces of the North (Phongsaly, Oudomxay, Samneua, Luang Namtha) produce some honey which they use for family consumption or which they sell at local markets. As described previously, the products are of variable quality and lend themselves badly to the transport, to the stocking and to the sale on markets of average range (mini-markets of Vientiane for example).
Nevertheless, the presence of these products on the local markets gives evidence of the existence of an beekeeping tradition in Laos and a market for honey.

The beekeepers learnt over the years when and how to harvest honey, to capture swarms in hollow tree trunks, which can be moved near the houses and benefit from a protection against the climatic disturbances and the predatory ones. These beekeepers have knowledge regarding harvesting techniques and are sometimes aware of the utility to collect only one part of honey in order to avoid the phenomena of desertion.

The incidence of the constraints met by the beekeepers with apiaries of *Apis cerana* can be attenuated by the introduction of innovations, bearing on the equipment and beekeeping practices.

Technical solutions thrifty and adapted to beekeeping in Laos

Top bar hives

The most effective innovation facilitating the control of the degree of maturity of honey and the management of the colonies is the introduction of the "Top Bar Hive". This hive, made up of a floor board and a brood box on which bars from 2.9 to 3 cm wide (cf. figure 3) makes it possible for the bee-keeper to observe the combs one by one and to limit swarming by facilitating the control of the production of queen cells.

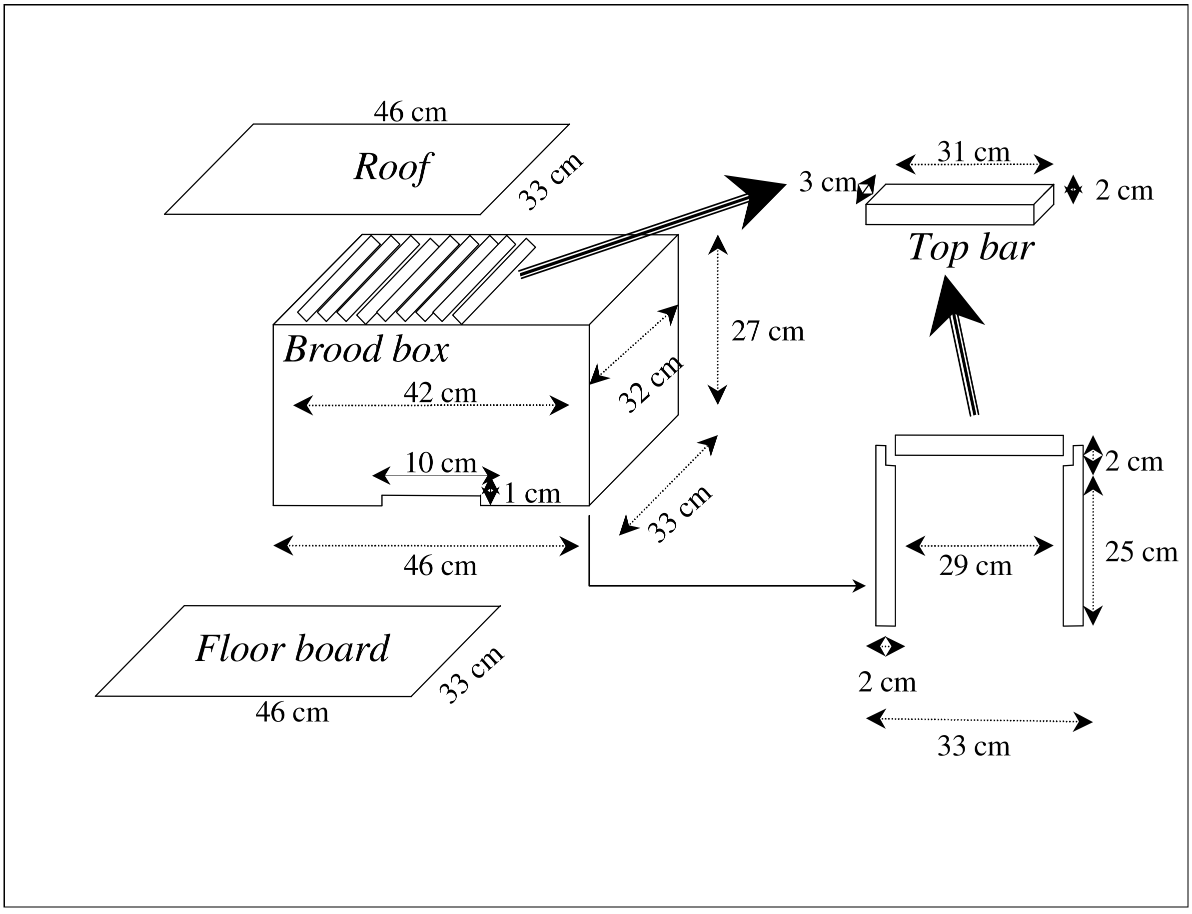


Figure 1 Plan of the top bar hives used by the Faculty of agriculture, campus of Nabong, LAOS

Thus, by facilitating the observation of the combs built by the colony, this hive allows the beekeeper:

- To control the health of the workers, the brood and the queen;
- To watch the predators or the parasites within the colony;
- To follow the state and the quantities of provisions in honey and in nectar.

This simple equipment, which can be easily built locally with wood falls for example implies a moderate investment, included between 20.000 and 50.000 kips (PDDP source, cf. P. 32).

Photo 7: Top Bar Hive built by the villagers. Province of Oudomxay

Photo 8: observation of a comb builds on a bar

This equipment is going to allow the beekeepers to improve the management of their swarms and the planning of their interventions on the apiary, whether it is for the harvest, the transfer in a new hive, the intensification of the swarms and for the most advanced the division of colonies, the management of the swarming.

Smoker

The beekeepers avoid opening the hives because of the inadequacy of these last ones and also of the stings inherent to the reactions of defence by the colonies. Some beekeepers choose to open their hives during the night. These blind interventions limit the quality of the work, bringing the beekeeper to harvest combs without distinction of maturity, or contents. Moreover, these kind of harvests cause damage which can induce a phenomenon of desertion/absconding from the hive.

The use of a smoker reduces the defensive reactions of the bees which, in the presence of the smoke, are going to ingest some honey in preparation for a hypothetical departure of a swarm. Bees have less inclination to fly and to sting. Having filled with smoke the entrance of the hive, the beekeeper can easily proceed to the necessary interventions. These can be thus programmed at any time of the day, rather during the periods of foraging, during which time the number of bees in the hive is at the lowest.

Rudimentary smokers can easily be built by the beekeeper starting from materials found near the apiary.

For example, a large piece of bamboo (diameter 10-15 cm - internodes 30-40 cm) can constitute the body of the smoker.

The chosen internode will be sawn in the middle and adjusted so that both halves can fit (Figure 2). An opening will be dug at the end of every half. In each will be laid out a low-size bamboo. The bamboo located at the base of the work will allow the beekeeper to blow to activate its smoker. The one situated at the top of the work will allow to evacuate the smoke and to direct it towards the swarm.

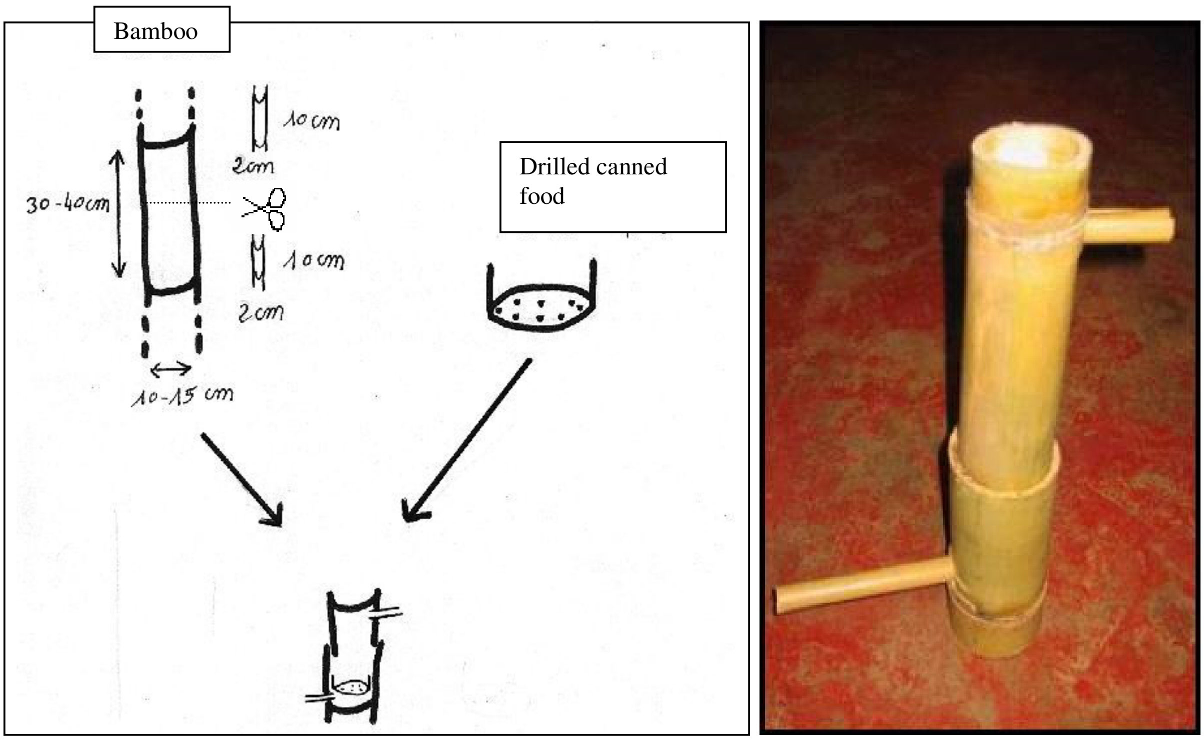


Figure 2 Construction of a smoker

Adequate protective clothing

Besides the smoker, it is recommended to have protective clothing which allows the beekeeper to intervene in hives in good conditions.

It is possible and quite easy to make a veil which effectively protects the face and the neck against stings.

A rudimentary veil can be made by sewing or by fastening a piece of gauze of mosquito net on a large straw hat which will avoid any contact between the mosquito net and the face.
In case the user prefers more protection, the addition of a cordon sliding in the bottom of the veil would allow it to be tightened at the level of the collar, preventing the bees from infiltrating and from reaching the face.

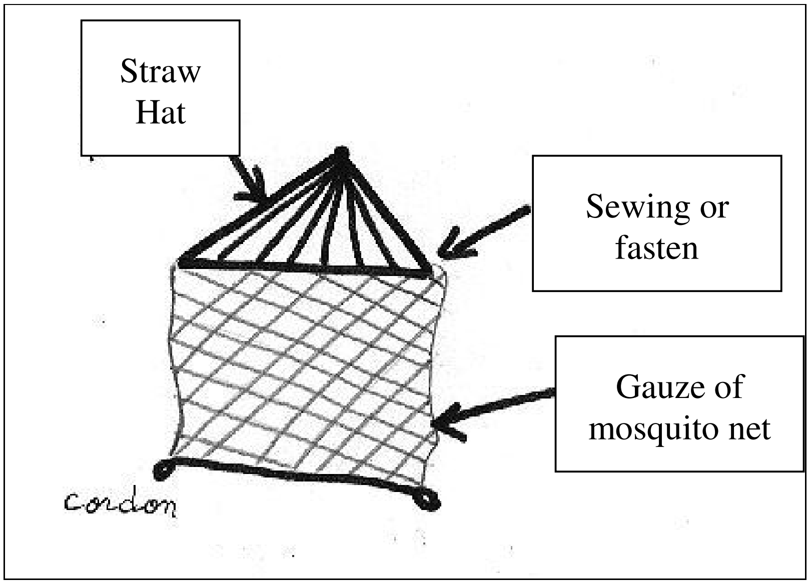


Figure 3 Veil to protect the neck and the face

Construction of a shelter for the apiary

The construction of a shelter under which to lay out the hives is the most effective means to fight against the pressures of predatory and climatic disturbances. Specifically adapted to the needs for the bees, the shelter will give to the farmer the means of controlling an apiary as well as possible.

Photo 9 Apiary of the Faculty of Agriculture, Nabong campus, LAOS

This rudimentary equipment gives the beekeeper the possibility of deciding on the management to be adopted.

Able to intervene constantly in his apiary, the beekeeper can plan more easily the interventions to operate in the best conditions.

Simple improvements of the practices

With these simple technical solutions, the beekeeper will be able thus to control many parameters influencing the state of the colony (parasitism, bad weather, provisions, swarming) and the quality of the products of beekeeping (degree of maturity of honey, impurity of honey).

The adoption of more adapted practices will be then possible and will allow the bee-keeper to excel in his art to optimize the management of its apiary in order to have strong colonies and to obtain a honey of better quality, in greater quantity.

Techniques that allow obtaining a honey of quality

Selective harvest

During the harvest in a top bar hive, the beekeeper can observe combs and choose those of which he will extract the honey. In the case of combs presenting a honey at an insufficient stage of maturity (uncovered cells), the beekeeper can decide, either to return the comb in the hive, or to collect only the part of the comb whose honey is sufficiently ripe.

Photo 10: Separation of the sealed cells of those containing a non-ripe honey (green) and brood

The part of the comb containing non-sealed honey and\or brood will be attached on a bar and reintroduce in the hive.

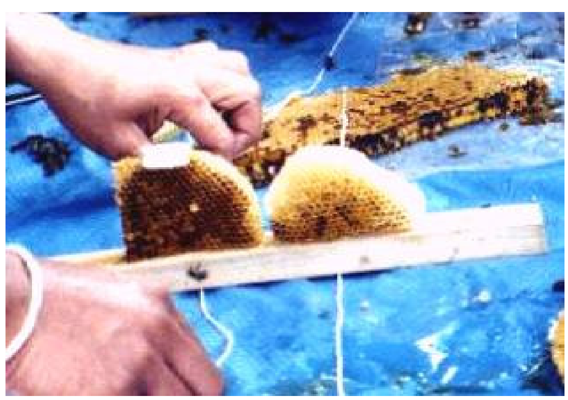


Photo 11: Attachment on a bar of combs containing green honey and brood

First processing of honey

As during the harvest, it is preferable to operate in dry condition or at least in an atmosphere having a low rate of humidity. It is, in particular, not advisable to proceed to the extraction and to the packaging in rainy season, during which the humidity of the atmosphere can quickly reach values close to 80%. As indicated previously, the moisture content of honey placed in the contact of such an atmosphere grows very quickly.

Separation and classification of combs

Once collected, the correctly sealed combs will be separated from the combs presenting irregularly sealed cells or presenting impurities (pollen, wax fragments).

Photo 12 Harvest of Honey - Nabong campus

These last combs will give honey of low quality. The water content and the presence of many impurities will confer to these honeys an important risk of fermentation. These honeys will preferentially be consumed or sold in the neighbourhood of the beekeeper.
Honey of higher quality will be handled carefully for conditioning and marketing under good conditions.

Pressure

Following this classification, combs with the various qualities of honeys will be pressed separately. This operation implies to remove the combs and to press them manually. The obtained paste can then be filtered.

Filtration

Filtration is crucial. It must allow separation of the honey from the majority of the impurities (wax fragments, pollen, waste, ashes of the smoker, died bee, larva) in order to prevent the contamination of honey by the germs conveyed by these foreign bodies.

In addition, during this operation, honey is not protected by the wax cover. It is in contact with the atmosphere from which it will tend to collect water. The longer the time spent in contact with the atmosphere, the more the water content of honey rises and the lower the quality of honey because of this increase in its content of water.

Let us recall that beyond 20% of moisture, honey becomes a medium whose osmotic balance is favourable to the development of yeasts. Honey is then in a process of fermentation which will appear more or less quickly, taking into account factors like the yeast rate of honey, the temperature, and the quality of conditioning.

It is thus advisable to adopt efficient filtration techniques allowing separation of honey and impurities in a reduced time. In the villages, it is possible to proceed in two times by using common ustensils. A first filtration, by means of a sieve or of a loose-knit tissue, will retain the large elements. This one will be completed by a filtration with a sieve or a tissue with thin stitches.

Photo 13 Loose-knit tissue and thin sieve used for the filtration of the honey

Hermetic packaging

After the operations of filtration, the honey will be placed in a carefully prepared hermetic packaging. The beekeeper will watch in particular that the container is clean and dry in order to preserve the quality of honey and to avoid new sources of contamination. He will also check that the container is hermetic, avoiding the sealing with plastic scrap, papers or paperboards which are not very efficient and potentially charged with undesirable germs.

The art of managing an apiary

The improvements in term of quality of honey will be all the more interesting as the quantity of honey will be raised and that thus the apiary will be well managed. This management will depend above all on the interventions carried out in the apiary and the dates on which they will have been realized.

Visit to the apiary and monitoring

The visit to the apiary is generally very instructive and provides information to the beekeeper about the general state of the colonies.

In addition regular monitoring of the apiary and its environment will allow the beekeeper to locate the factors that may limit the production of the apiary, whether they are of parasitic, climatic, or dietary origin.

Control of the pressure of the predators

Crucial information collected during these regular visits will be the importance of the parasites near the hive. *Apis cerana* bees have techniques of defence (wounding system) and intimidation (rustle of the abdomen) effective in front of most of the predators of their environment. However, it happens that, following successive and prolonged predations, the colony is weakened, what can involve a desertion and in all the cases a notable reduction in the population of bees and as a result the honey provisions.

The beekeeper will take care to limit the impacts of the predation while moving away the hives from the risky zones (dense forest, proximity of swarms of hornets, wasps, ants, bear), by isolating them from the ground and, as far as possible by treating the supports of the hive with repulsive materials (oil of draining).

Protection against the climatic phenomena

Another reason explaining the frequent desertion of the bees *Apis cerana* is the exposure to unfavourable climatic phenomena. Thus for example, the violent winds and rains of the periods of monsoon can weaken the colony which then will consume its honey provisions to maintain the homeostasis of the swarm. On the contrary, an exposure to the rays of the sun during the hot hours of the days of dry season causes a consequent increase in the temperature of the swarm, implying an important ventilation of the hive.

Until a certain limit, the bees manage to maintain a stability of the temperature and moisture of the atmosphere in the swarm. Beyond this limit, often exceeded at the hottest hours of dry season and wettest and windiest hours of season of monsoon, the swarms abandon the hive, which explains the numerous cases of desertion during these critical periods.

An attentive and careful beekeeper will reach, by taking care with the exposure of the hives to the sun and the dominant winds and, by choosing simple methods of protection (folding screen, sunshade, roof), the beekeeper will reach, to control the atmosphere inside the hive. This control will decrease the consumption of energy necessary to the ventilation and the maintenance of the temperature of the swarm as well as the frequency of the desertions.

Measure of the environmental potential

To accompany the development of his colonies, the beekeeper inevitably has to take into account the food aspects that are the availability in carbohydrates (nectar) and proteins (pollen).

That implies to define the foraging range of the colonies. In general, the bees *Apis cerana* can fly 500-700 m. The beekeeper will have to locate the perimeter so established and to qualify it by noting the inhabited areas, agricultural and forest spaces as well as the species which populate them.

Figure 4 Definition and qualification of a foraging range. This range is defined by the distance crossed by a bee (500 in 700m in the case of *A. cerana*). In this case, the foraging range recovers the village, rice fields (brown - dark), forests (yellow and green - light).

On the basis of this information, the beekeeper is able to build a calendar of flowering (cf. Table 6) and to define the periods favourable for foraging, to the production of honey and those of likely food shortage.

Construction of a calendar of flowering

From the observation of the foraging range, the beekeeper can gather information on the flora, the period of production of nectar, pollen, and honeydew. Collected on a calendar, this information is going to help the beekeeper to foresee the honey flow as well as the periods of food scarcity.

Espèces de plantes	J	F	M	A	Mai	Juin	J	Août	S	Oc
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3
Fleur de châtaignier										
Prunier; Mak Khong										
Pamplemousse										
Fleur de Melia azedarach										
Tamarinier										
Manguier										
Longanier										
Cerisier de Cayenne										
Carembolier										
Maïs										
Tournesol										
Riz de Rhay										
Riz de rizière										
Fleur de sésame										
Fleur de choux chinois										
Fleur de Elaegnus conferta										
Fleur de Bohinia variegata										
Fleur de cassia fistula										
Caesalpinia sappan										
Lagerstroemia										
Total	3	3	7	10	8	5	4	3	1	1
Classement			III	I	II					

Table 6 Calendar of flowering of the villages Ban Thiao and Ban Khoum (Province of Oudomxay)

From now on, the beekeeper will be able to plan his interventions in the apiary in order to optimize the management of the colonies.

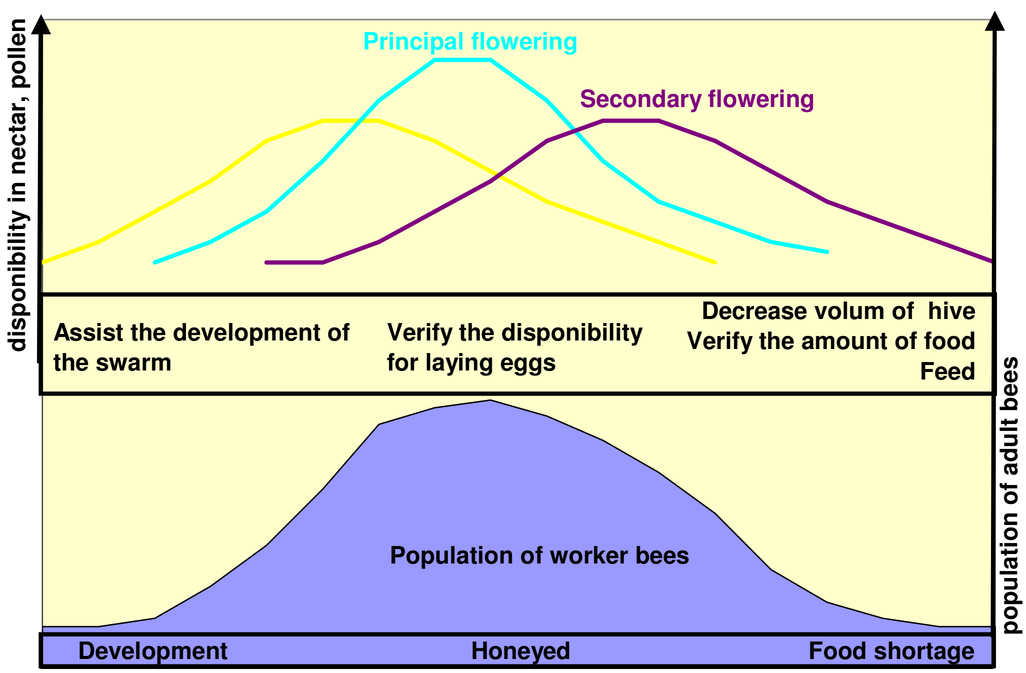


Figure 5 Practices adapted to the environmental events

Follow-up of the development of the colonies

Informed about the apiarian potential of the environment of the apiary, the beekeeper is able to define the maximum number of hives which he can settle in the apiary to avoid a too strong density of bees compared to the production of nectar and pollen. He can also optimize the development of colonies, by stimulating the laying of the queen, through the enlarging of brood spaces during the phase of establishment of the colony, by supervising honey stocks in period of food shortage and if necessary by bringing a food complement (sugar or syrup of sugar) to avoid the desertion from the hive.

Control of the state of combs

The regular follow-up of the development of colonies also makes it possible to preserve a favourable environment. Thus in period of harvest and food shortage, the beekeeper can decide to remove combs to collect honey or to decrease the volume of the hives. He must then take care to preserve the combs whose waxes are recent and, to remove those whose waxes are damaged. After a few months with brood, the cells blacken (succession of the cocoons produced by the pupae) and become sensitive to the developments of moulds, which can involve a departure of the colony.

Control of swarming (& and swarm collection)

The end of the rainy season is favourable to the breeding, by the colonies, of new queens who can lead to one or more swarming.

Swarming involves weakening of the colony of origin. However, given that this process is difficult to stop, the beekeeper should rather accompany it and collect the new swarms which are generally very vigorous.

By supervising his apiary, the beekeeper will be able to locate the periods of swarming. As soon as the swarm is formed, the beekeeper can capture it with a straw bowl placed over the swarm. Beforehand, the inside of this bowl will have been coated with beeswax.

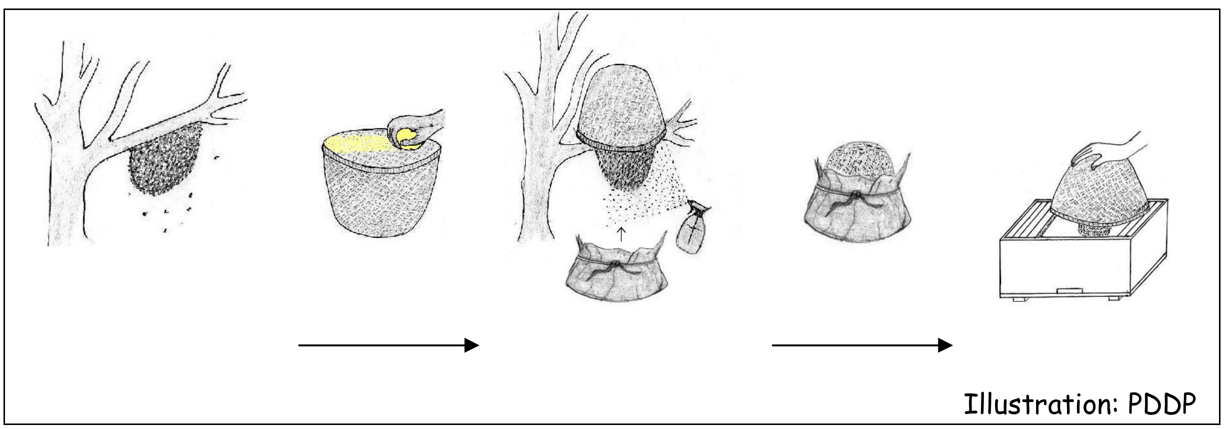


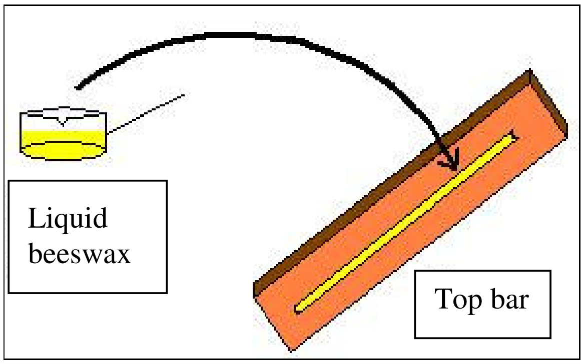
Figure 6 Capture of a swarm by means of a "straw bowl"

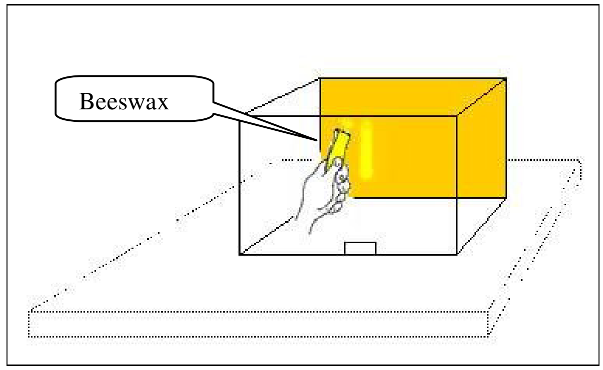
Gradually bees are going to settle down in the "bowl". It is then easy to transfer this swarm in a hive prepared for that purpose (cf. figure 7).

Preparation of a top bar hive for a new swarm

Preparation of top bars

To encourage the bees to build the combs in the longitudinal direction of the bars and in their medium, a starter can be deposited on these last. These starters from which the bees will build the combs can consist of beeswax. Once liquefied, the hot beeswax is deposited in the centre of the bar as it appears in the diagram below.





Preparation of the comb area

Before placing a swarm there, the hive must be cleaned and, if possible, briefly disinfected by the fire.

Then, the internal walls of the hive will be rubbed with a bar of beeswax in order to impregnate the wood of beeswax particles.

Figure 7 Preparation of a top bar hive for a new swarm

Beyond this minimal control of an apiary and colonies, the beekeeper will have, for a development of his apiarian activity, to refine his apiarian knowledge and know-how in order to supervise and cause the production of royal cells, to divide hives, to select stocks of bees having a lower propensity for swarming and desertion.

An effort of extension

In several provinces of Laos, small-scale beekeeping appeared in the course of the years. The development of this beekeeping with the species *Apis cerana* implies an effort of extension of the improved equipments and the innovative practices, on the basis of what was already begun in the Faculty of agriculture (campus of Nabong), in the provinces of Oudomxay and Phongsaly.

Development of a course and of pedagogical tools in the Faculty of agriculture

Aware of the beekeeping potential of Laos, several employees of the Faculty of Agriculture began in 2001 to develop a small apiarian unit on the campus of Nabong with the aim to have teaching tools for the course of entomology and the optional course of beekeeping and in addition to produce and market honey.

Following several attempts to capture swarms, to transfer wild colonies in hives and study trips in apiarian zones in Laos and in Thailand, the team gradually built an educational apiary on the campus of Nabong and developed a course "Beekeeping with the species *Apis cerana*". This course, proposed to the students involved in the fifth year of the program of BSc (Bachelor of Science), presents the world apiarian economy before focusing on the bee *Apis cerana*, its morphology, the organization of a swarm, the communication within the colony. In a second time are studied the traditional and improved apiarian practices as well as the quality of the productions obtained. A wide part of this course is dedicated to the practice. The students can experiment in particular the innovative practices and material (cf. syllabus in appendix 3). On a yearly basis, this course should allow to launch on the market about twenty professionals having theoretical and practical knowledge in beekeeping.

Support for the beekeeping activity in the project CBRDP (Oudomxai)

Noting that bee fauna is developed near Oudomxai and that there are traditional techniques of beekeeping in various villages, the Project for Conservation of the Nam Beng/Nam Nau and Nam Phak Watersheds began in 2002 an apiarian activity.

The objective was to identify the factors limiting the development of beekeeping and to propose solutions.

Very quickly, the technical team of the project proposed the introduction of bar hives, already used for beekeeping with *Apis cerana* in Nepal. In a concomitant way, technical training was organized in order to teach the villagers how to use these bar hives, how to build them and how to pull the best party of these hives.

Support for the beekeeping activity in the project PDDP (Phongsaly)

In the district of Phongsaly, the PDDP began in September 2002 an activity of improvement of apiarian techniques to allow the villagers to increase the quantity and the quality of the produced honey, while limiting the increase of the cost of labour.

During the exercise 2002/03, 5 villages were selected. It was proposed to the families wishing it to take part in a training on beekeeping and on the use of the bar hive. At the conclusion of the training, a bar hive was given for model to each village. This experiment, renewed in the identical in 2003/04, allowed the construction, in the 10 selected villages, of 104 bar hives by the villagers themselves. The production of honey of these last was more than 3 times higher than that of the traditional hives (respectively 2,4 and 0,7 litters).

In March 2004, the organization by the PDDP of a seminar "Beekeeping in the villages" made it possible to the participants to exchange on their apiarian experiments and in particular on the use of the bar hives. 22 villages took part in this seminar of diffusion of the improved techniques and began, afterwards, the construction of a hundred bar hives.

To extend the improved techniques?

The organization of training on the use of equipments adapted to beekeeping and on the improvement of the practices allowed to obtain interesting results such as the development of educational apiaries in the campus of Nabong, the development of beekeeping in villages targeted by the projects PDDP in the Province of Phongsaly and CBDRP in the province of Oudomxai.

To obtain these results on the scale of Laos would allow the development of a successful beekeeping with the species *A. cerana*.

It implies:

- To widen these actions of extension to all the provinces having an apiarian potential;
- To begin simultaneously a work of selection of swarms having a lesser inclination to abscond and to swarm.

Another apiarian alternative, the stingless bees

Another possible alternative is the development of beekeeping with other melliferous species which could stay in hives.

Thus various species of the Trigona genus, whose surface of extension includes Laos, may have a future in the agricultural systems of Laos.

Simple practices of management

Easy to hive stingless bees

The colonies of stingless bees can colonize various spaces:

- Basement, ant-hill: it is in particular the case of *Trigona collina* which seek an environment having low thermal amplitude.

Photo 14 Trigona collina

- Hollow tree trunk. In this case also the species *Trigona collina* and *Trigona fimbriata* choose these spaces because of their low thermal amplitude.

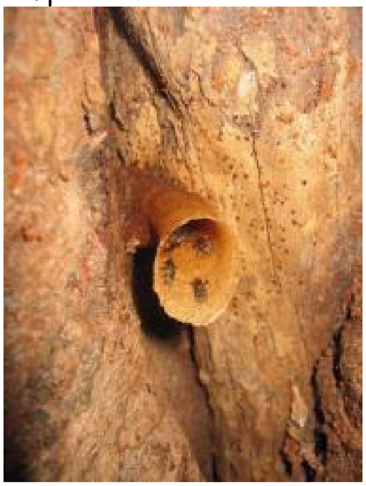


Photo 15 *Trigona collina*

Photo 16 *Trigona fimbriata*

- Tree trunks of small diameter and branches of trees. It is in particular the case of the species *Trigona laeviceps* that adapts itself to the variations in temperatures.

Photo 17 *Trigona laeviceps*

The installation in hive of the first two species is delicate, in reason of the inaptitude of these bees to adapt to the variations of temperatures of these closed spaces.

On the other hand, it is very easy to install a colony of *Trigona laeviceps* in a hive.

Taking of brood

Installation of cerumen

Positioning of pollen, brood and honey

A behaviour allowing an easy management of the swarms

The low-size bee (# 2 mm) of the species *Trigona laeviceps* also have the advantage of not having a wounding apparatus and not to be prone to the desertion, which makes easy the handling and the management of the hives.

It is also possible to divide the populous hives and thus and so to increase significantly a livestock in a very short time.

Photo 18 Hive with *Trigona laeviceps*

Production and pollination

This species has, besides, a strong faculty for pollination which completes the interest given by the production of small quantities of honey and pollen both very much wanted because of gustative quality for the first one and their energizing quality for the second.

Conclusion

At present little developed in Laos, beekeeping has nevertheless a favourable agro-ecological and socioeconomic context. It is likely that in the future, aware of these assets, the authorities of the country will support the development of this activity.

While choosing to support the development of this activity starting from the experiments accumulated by the beekeepers who raise already colonies of bees *Apis cerana* in the provinces of Laos and by making the effort to extend practices favourable to the production of a honey of quality in quantity, Laos will be able to reinforce its agricultural sector and to propose some of its natural advantages like the richness of its fauna and its flora or the leniency of its climate. This work of extension can right now lean on the experiences led within the framework of the projects of development in the district of Phongsaly (PDDP-CCL), and in the provinces of Oudomxay and Muang Mai (CBRDP-GAA) like with the Faculty of agriculture (PAFA-CCL).

By making this choice of the development of beekeeping with *Apis cerana*, Laos will give to the farmers a supplementary possibility of strengthening their system of production, thanks to a not too risky activity, presenting an interesting productivity.

In addition, the products of this rustic beekeeping could be developed on the niche markets of Laos and neighbouring countries, because of their specificity and their great intrinsic quality.

In the zones of fruit production, beekeeping (meliponiculture) with *Trigona laeviceps* is a credible alternative. In addition to the interest of an improvement of the pollination and thus of the quality and the quantity of the fruits obtained, these kind of beekeeping must allow the production of small quantities of honey and of pollen appreciated in South East Asia for their medicinal virtues.

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Teaching equipment

Handbook

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Annex 1 Calendar of flowering in the neighbourhood of the Faculty of agriculture - campus of Nabong, Prefecture of Vientiane

Name in Lao	Scientific name	Flowering period (month)											
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Dok Makphao (fleur de cocotier)	Cocosnuci fera linn	■	■	■	■	■	■	■	■	■	■	■	■
Dok Makkham (fleur de tamarinier)						■	■	■	■				
Dok Ngieu	Ceibapentandra	■										■	■
Doktakop		■	■	■	■	■	■	■	■	■	■	■	■
Dokmaknao (fleur de citronnier)	Citrusauranti forlialo	■										■	■
Dok Makkathanh (fleur de jujubier)	Ziziphusma writana						■	■	■	■			
Dok Makmouang (fleur de manguier)	Anacardium Occidentalel	■	■									■	■
Dok Maktong		■	■										■
Dok Makhoung (fleur de papaye)	Caripapaya						■	■	■	■	■		
Dok Khoun	Golden Flower Cassia Fistula			■	■	■							
Doksom Oe	Cibusgrandis (L) Osbeek			■	■	■	■						
Dok Champa	Michelia Cham Pacalinn			■	■	■	■						
Dok Kadan Nga	Thevetiaper Uviana (pers)					■	■	■					
Dok Kha	Alpinia Kha					■	■						
Dok Makhoung	CaricaPapaya						■	■	■	■	■		
Dok Khilek	Cassia garrettiana Khi le dong						■	■	■	■			
Dok Sa	Cinnamomum cassia-sa						■	■	■	■			
Dok khikay	Ccipadessa baccifera- Khi khay				■	■	■						
Dok Maknao	Citrus medica –nao	■										■	■
Dok Mak Eua									■	■			
Dok Maksay			■	■	■	■							
Dok Mak Heuk						■	■						
Dok Kheme	Ixora stricta – khem deng				■	■	■						
Dokkouay May (fleur d'orchidée)						■	■	■	■	■			
Dok Mantonh (fleur de manioc)	Manihot utilissima – manton							■	■	■			
Dok Gnagnoup	Mimosa diplotricha – youbyob	■	■	■	■	■	■	■	■	■	■	■	■
Dok Tè	Sindora Siamensis – tè nam				■	■	■						
Dok Kadan Gna	Thevetia peruriana – Sa abng				■	■	■						
Dok May Soth (fleur de bambou)				■	■	■							

Annex 2 Report on beekeeping in the village of Oudomxay Province

List of the farmers visited with a beekeeping unit
Villages of the valleys Nam Beng, Nam Mau, Nam Phak - Province of Oudomxay

M. Lao

Ban Na Ngiu

Family : 8 persons among whom 3 are active

2 ha Rice + Maize
2 ha vegetable
6 sows

Beekeeping unit: started in 2002
In March 2003 : 5 hives
M. Lao sold 10 kg of honey (grad 1) at the price of 20000 kip/kg and wax at the price of 15000 kip/kg.

Mr. Thun

Village : Ban Houay Houm (12 families have a beekeeping unit in this village)

Beekeeping unit: started five years ago
3 hives which produce 2 kg/year

Mr. Mayphou

Village: Ban Houay Houm

Family: 12 persons, 8 are children

2 ha of rice
Fish breeding
2 pigs
4 buffaloes (2 males, 2 females)
Beekeeping unit: started two years ago
10 hives, with 2 far away from the house. Only 2 top-bar hives (TBH)
M. Lao Sold 24 kg of honey (grad 1) to the project
Traditional hives : easy to populate
Hive TBH: - difficult to populate
+ easy to manage

Mr. Mayvong

Village: Ban Phon Saat

Family: 10 persons, 8 are children

6 ray of lowland rice,
3 ray of upland rice (Slash and burn)
Small animal breeding
Braiding of grass (Imperata cylindrica) for the realization of roofing units
Beekeeping

Beekeeping unit: started two years ago
However Mr. Mayvong has a long experience with bees
12 hives

Thorough study of the production system of Mr. Mayvong
Village Phon Saat – Province of Oudomxay

M. Mayvong is a farmer in Phon Saat , a village of Oudomxay province.
Married, Mr. Mayvong has 8 children of which 4 are already married

I- PRESENTATION OF THE SUB-SYSTEMS

Lowland rice

3 plot of land of 2 ray (1600 m^2), which is an approximate total of 1 ha. The exploitation counts 2 active persons to which are added auxiliary labour for the transplantation and the weeding of rice. The quantity of work available per month can be estimated at approximately 38 days.

This production system counts 5 principal sub-systems:

- Low land rice,
- Upland rice
- Small animal breeding
- Braiding of grass (*Imperata cylindrica*) for the realization of roofing units
- Beekeeping

Working time:

- In May:
    - Cleaning of the irrigation system — 2 days
    - Repair fences — 1
    - Repair water leakage — 1
    - Ploughing — 1.5
    - Preparation of seeds — 0.5
    - 2nd ploughing — 1.5
    - sowing — 0.5
    - 1st Preparation of seedlings — 2
    - the rice seedlings are then put in water during — 15 days
    - 2nd preparation of seedlings — 2

- In June:
    - Transplantation (3j * 4 persons) — 12
    - Fences strengthening — 2

- In July, August, September:
    - Weeding — 5
    - Control (3 times per month – 1 to 2 hours each time) — 1

- In October:
    - Harvest (3-4 persons * 2 j) — 8
    - Drying during — 5
    - Sheaf harvest — 4
    - Manual threshing — 8

Gross Product (GP):

- 1,3 t * 1000 kip/kg -> 1.300.000 kip

IC :

Seeds: 55 kg	->	55.000 kip
Taxes on water	->	8.500 kip
Tax on land	->	28.000 kip

	Total : 91.000 kip	

Fcc :

Ploughshare plow 25.000 kip/3 years	- > 8000 kip
Handle plow: 6000 kip/6 years	- > 1000 kip
shovel 8000 kip/8 years (2 rice systems)	- > 500 kip
pickaxe: 25000 kip/10 years (2 rice systems)	- > 1250 kip
harrow: 20000 kip/2 years	- > 10000 kip
yoke: 10000/15 years	- > 7000 kip
machete: 20000/5 years (2 rice systems + grass braiding)	- > 1300 kip
sickle: 3000/5 years (2 rice systems + grass braiding)	- > 200 kip
Fan: 3000/3 years (2 rice systems)	- > 500 kip
Nate: 50000/5 years (2 rice systems)	- > 5000 kip
Basket: 2*15000/2 years (2 rice systems)	- > 7500 kip

Total	42.750 kip

VAN :

VAN = GP – IC – Fcc
= 1.300.000 – 91.000 – 42.750
= 1.166.250 kip
= about 108 USD (at the exchange rate in use at the date of the investigation)

Ratio :

Area per active person: 0.67 ha
VAN per active person: 72 USD / active
Productivity: 2,1 USD / man day

Up land rice (slash and burn)

1 plot of land of 0.5 ha

Working time:

- In February:
  - Equipment preparation — 0.5 day
  - Location on zone — 0.5
  - Slash — 7
  - The cleared zone is then left for drying during — 25 d

- In March:
  - Burn — 0.5
  - Clearing — 9
  - Fences construction — 5

- In April :
  - sowing (20 persons * ½ d) — 10
  - Control (5 times 0.5 d) — 2.5

- Between May and September:
  - Weeding 1 — 10
  - Weeding 2 — 30
  - Weeding 3 — 10
  - Fences strengthening — 1

- Between October and November:
  - Harvest — 9
  - Sheaf harvest — 3
  - Manual threshing + transport (3 persons * 5 d) — 15

GP :

1 t * 1200 kip/kg -> 1.200.000 kip

IC:

Seeds: 30 kg -> 36.000 kip

Total : 36.000 kip

Fcc:

shovel 8000 kip/8 years (2 rice systems)	- > 500 kip
pickaxe: 25000 kip/10 years (2 rice systems)	- > 1250 kip
machete: 20000/5 years (2 rice systems + grass braiding)	- > 1300 kip
sickle: 3000/5 years (2 rice systems + grass braiding)	- > 200 kip
Fan: 3000/3 years (2 rice systems)	- > 500 kip
Nate: 50000/5 years (2 rice systems)	- > 5000 kip
Basket: 2*15000/2 years (2 rice systems)	- > 7500 kip
Axe 1: 18000 / 5 years	-> 3600 kip
Axe 2: 15000 / 7 years	-> 2100 kip
hoe: 2000 / 4 years	-> 500 kip

Total	22.450 kip

VAN:
VAN = GP – IC – Fcc
= 1.200.000 – 36.000 – 22.450
= 1.141.550 kip
= About 107 USD (at the exchange rate in use at the date of the investigation)

Ratio:
Area per active person: 0.33 ha
VAN per active person: 71 USD / active
Productivity: 0,94 USD / man day

Small animal breeding

- Chickens: 20
- Ducks: 4
- Cows: 3 - Sold for 1.850.000 kip
- Buffalo: 1 - Sold for 1.800.000 kip

The farmer wished to save time on ploughing by paying for the service - 100.000 kip/ha. This is the reason that explains why he sold the cows and buffalo.

The working time for caring for the remaining animals is negligible

Braiding of grass (*Imperata cylindrica*) for the realization of roofing units

The grass *Imperata cylindrica is harvested* in the zones of savanna of the vicinity.
The farmer makes these activities during the periods of spare time.

Working time:

o Harvest:	4 days
o Sheaf harvest:	1
o Transport and preparation	20
o Braiding (from 19h00 to 21h00 or 22 h during 2 months)	30

GP:
400 pieces are produced and sold 1000 kip -> 400.000 kip

IC: -> 0

Fcc:

machete: 20000/5 years (2 rice systems + grass braiding)	- > 1300 kip
sickle: 3000/5 years (2 rice systems + grass braiding)	- > 200 kip
	-------------
Total	1500 kip

VAN:
VAN = GP – IC – Fcc

= 400.000 – 0 – 1.500
= 398.500 kip
= about 38 USD (at the exchange rate in use at the date of the investigation)

Ratio:
VAN per active person: 25 USD / active
Productivity: 0,67 USD / man day

Beekeeping

This activity is relatively new on the farm, although Mr. Mayvong has a long experience of working with bees.
Last year, he had 6 hives among which 4 produced honey. He sold 8 kg of honey (grade 1) at the price of 20.000 kip/kg.

This year he has 12 populated hives and 12 empty hives. He plans to increase its livestock to 50 hives, which would allow him to live only of this activity.

Working time (12 populated hives + 12 empty hives):

- Construction or maintenance of hive (6 hives/year: ½ day/hive) - > 3 days
- monitoring: 2 half-days per month - > 12
- Placement of the hives in forest(November-December) - > 8
- Harvest: 2 H/hive (March - April) - > 3

Total : 26 days

GP:
- 2 kg (grade 1) per hive * 20.000 kip / kg -> 480.000 kip
- 2 kg (uncovered) per hive * 10.000 kip / kg -> 240.000 kip

IC: -> 0

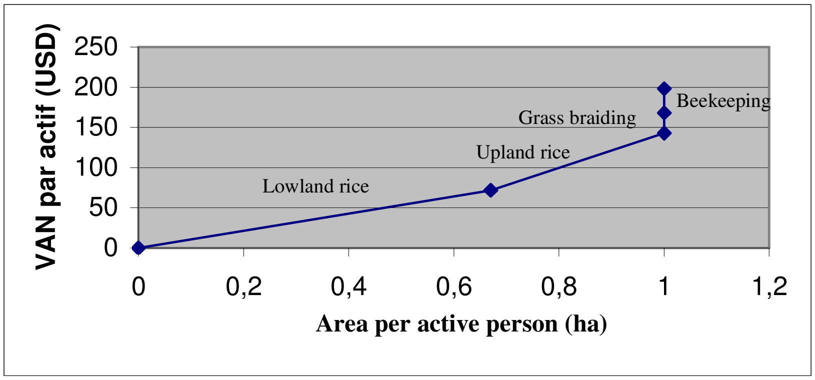
Fcc: 25 % of the hive to build each year : 6 hives
(3 traditional hives, 3 Top bar hives)
1 Top bar hive = 50.000 kip) -> 150.000 kip

VAN:
VAN = PB – IC – Fcc
= 720.000 – 0 – 150.000
= 570.000 kip
= About 55 USD (at the exchange rate in use at the date of the investigation)

Ratio:
VAN per active person: 30 USD / active
Productivity : 1,95 USD / man day

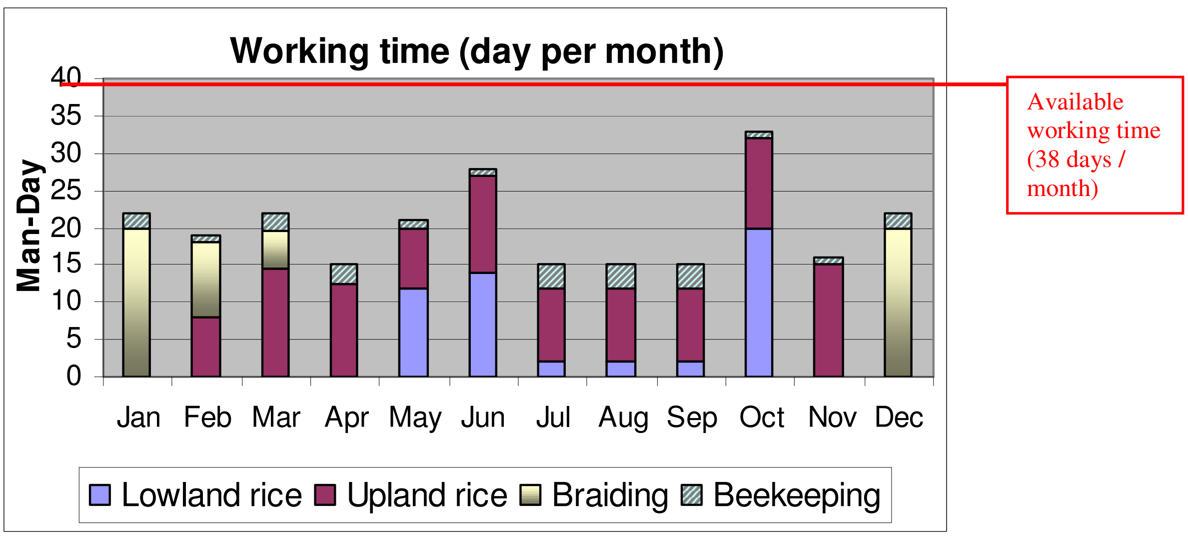
II- ANALYSIS OF THE PRODUCTION SYSTEM OPERATION

On the graph below, it appears that the principal sources of income are the 2 rice subsystems.



The 2 other subsystems make it possible to strengthen the production system. They a VAN of 55 USD per active person, which is close to the ¼ of the VAN of the system.
Moreover, they are incomes in monetary form.

Working schedule



There is a complementarity between the 4 sub-systems. The working times of the braiding and beekeeping systems are not fixed in the year and can be distributed during the time when the workload is lower.

Nabong,, 8 of April 2003

Annex 3 Syllabus of the course BEEKEEPING WITH *APIS CERANA*

Faculty of Agriculture — **Course : Beekeeping** — **Credit : 2(2-1-0)**
Program : BSc 5, Sem 9 — **teacher: Bounpheng SENG NGAM** — **Unit : Option**

Goals:
- *To permit students to have the basic knowledge in environmental conditions and societies of bees*
- *To permit students to understand the relation between crops and apiculture*

Objectives	Contents	References	Methods	hours	Evaluation
PART 1 – CONTEXT					
- To present the panorama of world apiculture - To increase students awareness that there is a world market of honey, regulations managing the international exchange of honey.	**<u>Chapter 1</u>** : 1. Honey in the World 1.1 Production, localization and evolution 1.2 Consumption, localization and evolution 1.3 Exchanges between countries 1.3.1 Honey in the region 1.3.2 At the European level 1.3.3 At the World level 1.4 Regulation	 1,2 1 5 6,7 3,4	 L TU	 4h	
- To replace in the times, appearance of melliferous insects class. - To indicate the evolution of animal kingdom	**<u>Chapter 2</u>** : Appearance of agriculture 1. Chronology of geologic era 2. The insect class 3. Systematic Genesis of Apis genus	 1 1 A,B 5	 L	 2h	

To indicate the importance of social organization of a colony.	**Chapter 3** : Social insects				
	1. Communication		L	3h	
	1.1 Dances and Bee hissing	A,B,4,6	Film	1h	
	1.2 Chemical				
	2. Notion of super-organism	4			
	3. Social Organization in a swarm				
	- 3 castes	4,6			
	- The activities of the queen, the workers and the drones		P	2h	
	4. Practice 1 : Observation of a beehive – observation at the entry – observation of antenna contact, effect of the smoke, observation of the gland of Nasanov - Veil construction				
PART II – BEES, MORPHOLOGY, ANATOMY, ALIMENTATION, DISEASES					
- To observe the general morphology of 3 castes - To understand the function of digestive, respiratory, circulatory and reproductive systems.	**Chapter 4 :** Morphology, Anatomy				
	1. Morphology of 3 castes		L	4	
	2. Anatomy				
	- Study of the digestive system of bees	C,B			
	- Study of the respiratory system	C			
	- Study of the circulatory system	C			
	- Study of the reproductive system	C, TP3			
	3. Practice 2 : Morphology of a worker-bee (head, thorax, abdomen, wings).	B	P2	2	
	4. Practice 3 : Morphology of a drone, general morphology, anatomy of general organ	B	P3	2	
	6. Calendar in beekeeping				
	6.1 From the egg to the queen	C	L	2	
	6.2 From the egg to the worker	C			
	6.3 From the egg to the bumblebee	C			
	6.4 Activities of workers	C			

- To indicate the symbioses between the pollinators and phanerogames	**<u>Chapter 5:</u>Feeding**				
	1. Plants giving flowers	L	3		
	1.1 Systematic of life – parallel evolution of vegetable and animal kingdoms				
	1.2 Botany				
	2. Adaptation of bees to flowers				
	2.1 Morphological and anatomical appearances				
	2.2 Proteins and carbohydrate needs of bees				
	2.3 The supply of the hive: for consumption and for storage				
	2.4 P4: honey analysis: concentration in water, results interpretation in standard of honey.	P	3		
-	**<u>Chapter 6:</u> Pests and Diseases**				
PART III – BEEKEEPING					
- To mark the situation permitting the appearing of apiculture	**<u>Chapter 7:</u> Toward the apiculture**				
	1. Apiculture, the long history	A	L	3	
	1.1 Definition	D			
- To indicate the importance of environment in apiculture	1.2 From destruction to management of bees				
	1.3 Hunter of honey				
- To know the flowers giving the honey and to estimate the potential of agricultural zone	1.4 The first beekeepers				
	1.5 Langstroth 'revolution': the 'bee space	A			
	2. Apiculture principals				
	2.1 strong tendency to the environment	A			
	2.1.1 Climate				
	2.1.2 Sources of pollens and nectars				
	2.1.3 Gathering zones				
	2.2 Environmental potential for apiculture	1			
	2.2.1 Approach this potential by flowering calendar		P	3	
	2.2.2 Flowering calendar				
	• Flowering calendar presentation				
	• Making a flowering calendar in Nabong Campus				

	Chapter 8: beehive 1. The beehive, the important material for managing the colony 2. Beehive evolution 3. The major discovery : Bees space 4. Length of shelf and its space 5. Advantage and weakness of beehives 6. Beehive management – beehive conduct 7. Beehive structure P6- Observation and handling of beehive 8. Notion of Production System P7- Investment calculating and profit earning of different systems	A D (See Point1)	L P L P	 2 2 1	
	Chapter 9: Practice 1. The transfer of a swarm to the beehive **2.** Selective harvest of honey	P P	3 2		

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A. Beekeeping for honey production in Sri Lanka RWK Puchihewa, 1994
B. Apiculture, P. Jean Prost, ed Lavrier, 1987
C. Traité de l'apiculture, Rustica
D. Apiculture de petite échelle – Peace Corps, 1982

Chapter 1.

(1)- Chronological Series FAO (www.fao.org) database
(c)(2)- Traité de l'apiculture – publication Rustica
(3)- Norme miel du *codex alimentarius* (www.fao.org\docrep\w9114f\w9114fol.hotmail.com)
(4)- Directive miel (www.apiservices.com\database\regislation\directive-européenne_miel_20_12_2001.hotmail.com)
(5)- Vietnam : 2ème exportateur de miel Asie (www.beekeeping.com\articles\fr\vietnam_exportateur.hotmail.com)
(6)- cif prices in main european ports : (www.beekeeping.com\databse\honey-market\europe-af.hotmail.com)
(7)- Etude du marché du miel dans l'union européenne (www.beekeeping.com\rfr\articles\marché_miel_uc.hotmail.om)
(8)- honey situation outstock in selected countries (www.beekeeping.comdatabase\honey_market\fao_report_99.hotmail.com)

Chapter 2.

(1)- Chronologie des âges de la terre et (http:\\hattice.lirguist.jussieu.fr\articles.phd3 id_article_64)
(A)(2)- beekeeping for honey production in Sri Lanka RWK Punchihewa, 1994
(B)(3)- Apiculture
P. Jean Prost, ef Lavrier, 1987
(C)(4)- Traité de l'apiculture, Rustica
(5)- Thesis of Rémy Vandame

Chapter 3.
(A)- Beekeeping
(B)- Apiculture
(C)- Traité Rustica
(4)- Abeille qui est-tu ?
(5)- Abeilles et apiculture
(6)- Abeilles mutantes

Chapter 6: (1) Rapport de mission de voyage d'étude – apiculture villageoise dans la province d'Oudomxay – mai 2003