Available Online at ESci Journals
International Journal of Agricultural Extension
ISSN: 2311-6110 (Online), 2311-8547 (Print)
http://www.escijournals.net/IJAE

APICULTURE AND POLLINATOR INDUSTRY SURVEY IN THAILAND

Chama Phankaew
Department of Entomology, Faculty of Agriculture, Kasetsart University, 50 Ngam Wong Wan Rd., Lat Yao, Chatuchak, Bangkok.

A B S T R A C T

Present study was conducted in Chiang Mai and Chiang Rai provinces are the part of this honey zone producing. This zone is the lychee and longan production in-season. Samut Songkhram province is another lychee production zone and Chanthaburi province is longan production zone in off-season. Total 22 beekeepers were selected by using snowball sampling technique. The 11 bee experts, 4 bee researchers, 9 longan and 6 lychee orchard owners were selected as respondents through purposive sampling technique. The collected data were statistically analyzed with the help of Statistical Package for Social Sciences (SPSS). Findings revealed that 4 bee species: European honeybee (*Apis mellifera ligustica* L.), Asian honeybee (*A. cerana indica* F.), giant honeybee (*A. dorsata* F.) and stingless bees (*Tetragonula pagdeni* (Schwarz) and *T. laeviceps* Smith) used by beekeepers in Thailand. However, the main species in the bee industry is the European honeybee with 300,000 colonies and the farm value of bee products is about 37.7 million USD and honey export value of 17.1 million USD in 2012. The key nectar crops are longan, lychee and Siam weed. The key pollen crops are corn, giant mimosa and sensitive plant. The peak activities of honeybees are within 4 months starting in December to March which coincide with the availability of the 3 main nectar crops. The biggest challenges, according to beekeepers surveyed, are food sources (25.6%) and the Tropilaelaps mite (25.6%). The bee pollination industry is most developed in the northern provinces and there is a potential to develop in other parts of Thailand. The future of apiculture industry in Thailand is still on the rise because the demand of honey and other bee products both at national and international levels is increasing and the volumes of bee products are not sufficient at present.

Keywords: Apiculture, insect pollinators, beekeepers, pesticides, bee products.

INTRODUCTION

Bee keeping has been carried out in Thailand for more than 100 years. The European honeybee was introduced into the country 70 years ago, that was the beginning of the apiculture industry. Apiculture is a profitable profession, and bee products have been hammering high market prices (Kongpitak, 2004). Habitat loss and fragmentation, pesticides, pathogens, climate change, invasive species, intense management of managed bees, and decreased interest in beekeeping have all been suggested as threats to bees and pollination services, but the relative importance of these drivers remains uncertain (Potts *et al.,* 2010; Vanbergen, 2013). In Brazil, the high frequency of bee deaths gave rise to the Bees Protection Campaign (BEE OR NOT TO BE) and the development of the BEE ALERT, an electronic device, which allows all beekeepers and researchers identify on a world map, on line, any occurrence of death or disappearance of Apis mellifera bees, stingless bees and bees in general. After 14 months of data the BEE ALERT device registered in Brazil losses of more 15,000 bee colonies in 14 states. The number of lost colonies corresponds to an alarming statistic of about 900 million bee deaths mainly due to pesticide. (Goncalves & Castilhos, 2015). More recently, the use of neonicotinoid insecticides has been specifically pointed out as a factor that might contribute to declines of both managed and wild bees (Sluijs *et al.,* 2013; Goulson, 2013). In Europe, concerns about the impact of neonicotinoids on honeybees have led to regulatory review of these pesticides (Tjeerd *et al.,* 2012).

Tropilaelaps mites are parasites of honeybee brood. Feeding on bee larvae and pupae causes brood

* Corresponding Author:
Email: fellymee@yahoo.com

malformation, death of bees and subsequent colony decline or absconding. Development requires about 1 week, and the mites are dispersed on bees. There are at least 4 species in the genus Tropilaelaps. Each species is closely associated with a particular giant honey bee in Asia. Two species (T. clareae and T. mercedesae) are damaging pests of Apis mellifera. The other two species (T. koenigerum and T. thaii) appear to be harmless to A. mellifera (Anderson & Morgan, 2007). Syndrome of Tropilaelaps mite infection include a shorter lifespan, lower body weight, and shrunken, deformed wings and legs. These bees may be seen crawling at the entrance to the hive. As with Varroa mites, Tropilaelaps has been associated with infection and spread of deformed wing virus. Other syndrome include: irregular and poor brood patterns with patches of neglected brood and perforated cappings (due to worker bees attempting to clean out sick or dead larvae) (Lea, 2015).

Another problem of apiculture, when bees do not have access to pollen, they can utilize their protein for brood rearing until their protein content drops to 20% of their body weight (Black, 2006). At the same time, the queen bee stops laying eggs, and the colony population weakens. In this case, the colony may be offered a pollen substitute, which is food intended to completely replace pollen (Manning *et al.,* 2007). However, there are several problems facing the nascent Thai beekeeping industry, notably lack of food sources and various diseases and mites (Kongpitak, 2004). In Thailand, there is discernible in bee population or bee health. However, pesticides are one of the perceived problems identified by Thai beekeepers from an exhaustive list.

This study is aimed to review apiculture industry in Thailand to see the different problems facing the industry, the development and future of this industry. The study will use questionnaires given to beekeepers and orchard owners, the information also comes from in-depth interviews with bee experts and researchers and reviewing of publications.

METHODOLOGY

Northern Region of Thailand is famous for the honey production and generally denoted as honey or beekeeping zone. Chiang Mai and Chiang Rai provinces are the part of this honey zone producing significant amount of honey production. This zone is the lychee and longan production in-season. Samut Songkhram province is another lychee production zone and Chanthaburi province is longan production zone in off-season. List of beekeepers, bee experts, bee researchers and lychee and longan orchard owners served as sampling frame developing implication of sampling technique. This technique was preferred for the selection of study area and respondents. List of beekeepers and bee experts and details of Chiang Mai and Chiang Rai provinces were obtained from the office of Agricultural Technology Promotion Center (Economic Insects) Chiang Mai province and Northern Beekeeper Association of Thailand. List of bee researchers were obtained from the office of National Research Council of Thailand. List of longan and lychee orchard owners and details of Chiang Mai, Samut Songkhram and Chanthaburi provinces were obtained from the Office of Agricultural Economics and Provincial Agricultural Extension Office. (1) The beekeepers of Chiang Mai and Chiang Rai provinces were selected as study area by using snowball sampling technique on the large farm (≥300 colonies). There were total 22 beekeepers in these provinces (6 beekeepers in Chiang Mai and 16 beekeepers in Chiang Rai; N=100 beekeepers). (2) The 11 bee experts in Chiang Mai province were selected by using purposive sampling technique on the more experience of beekeeping and the owner of bee business (≥10 years; N=20 bee experts). (3) The 4 bee researchers were selected by using purposive sampling technique from the office of National Research Council of Thailand list (N=10 bee researchers). And (4) the 9 longan and 6 lychee orchard owners were selected by using purposive sampling technique on the large orchard (≥100 rais) and bee colonies visiting recorded within 5 years (N=30 longan and 10 lychee orchard owners). For the sake of data collection interview scheduled was used as research instrument. Literacy level of the district was not up to the mark and it was preferred to interview the sample personally. Considering the objectives of the study, interview scheduled was prepared. Interview scheduled was mix of close ended and open ended questions. With regard to the question on perceived problems facing the industry, respondents were prompted to choose multiple problems from an exhaustive list. The questionnaires then further probed respondents on their perception of the problems caused by pesticides by asking them a series of questions related to severity of impact, peak seasons and knowledge about pesticide use. The questionnaire contains 4 parts aimed at measuring: (1) demographic information, (2) exposure to value of bee

products information, (3) show the different problems facing the industry, and (4) the development and future of this industry for conservation insect pollinators. Validity of interview scheduled was checked through face validity technique. For the purpose, interview scheduled was checked by two professor of entomology department at Kasetsart University and the office of Agricultural Technology Promotion Center (Economic Insects) Chiang Mai province, Thailand. Reliability was checked by using Cronbach alpha with the help of SPSS. Before final data collection, instrument was pre-tested on 10 beekeepers other than study respondents. Final data collection was carried out during August to October, 2014 by using questionnaires to get information with face to face interview from 22 beekeepers, 9 longan orchard owners and 6 lychee orchard owners. In addition, information also comes from in-depth interviews with 11 bee experts, 4 bee researchers and reviewing of publications for other data. Collected data were analyzed using Statistical Package for Social Sciences (SPSS). Descriptive statics technique was used for the data analysis.

RESULT AND DISCUSSION

Beekeeping in Thailand: There are two types of bee keeping in Thailand. The first one is for additional income and there are 3 species of bees being used for this one (Information from bee researchers and bee experts).

1. Stingless bees (Tetragonula pagdeni (Schwarz) and T. laeviceps Smith), this type of bee is used mainly for pollination of fruit trees in the eastern part of Thailand. There are about 5,000 colonies of stingless bees, the by-products are honey and propolis with very small value. The beekeepers also sell colonies of stingless bees to fruit orchard owners to use for pollination.
2. Asian honeybee (Apis cerana indica F.), this type of bee distributes in northern, central and southern parts of Thailand. Beekeepers use different types of materials to lure the bees from the nature. There are about 10,000 colonies and the honey is harvested only once a year in April which is believed by Thai people to be the best quality of honey. One colony gives about 3 litres of honey per year.
3. Giant honeybee (Apis dorsata F.), this type of bee found only in swamp tea tree forest, Songkla province. This is a very old tradition carried out by local people for more than 100 years. Beekeepers use big tree branches covered by swamp tea tree branches to lure the bees from the nature. There are about 1,200 colonies per year and the honey is harvested 4 times/year with 34L honey/ colony.

Table 1. Bee products in 2013-2014 with farm prices, volumes and values.

	Products	Price/kg (THB)	Volume (Ton)	Value (THB)
Major honey	Longan honey	82.78	18,355.36	758,786,341.14
	Lychee honey	71.21	5,179.59	181,846,494.99
	Siam weed honey	67.46	3,538.41	122,021,624.51
Minor honey	Sunflower honey	80.00	186.83	14,946,714.03
	Coffee honey	100.00	0.27	26,642.98
	Sesame honey	75.00	140.67	10,550,621.67
	Para rubber honey	60.00	125.89	7,553,285.97
	American rope honey	110.00	11.99	1,318,827.71
	Romerillo honey	50.00	11.99	599,467.14
Other products	Pollen	415.72	125.32	52,098,962.50
	Royal jelly	1,381.25	53.62	74,064,249.93
	Beeswax	154.18	286.23	44,128,791.03
	Broods	125.00	7.78	972,413.79
Total				1,268,914,437.39

Remarks: Calculation of the information from beekeepers and bee experts.

The second objective is for apiculture industry and there is only one species used for this one, the European honeybee (Apis mellifera ligustica L.). It was introduced into the country 70 years ago. There are about 300,000 colonies mainly in the northern provinces i.e. Chiang Mai, Chiang Rai, Lamphun, Lampang, Phayao, Phrae, Nan and Uttaradit. It is also in other parts such as Nakhon Ratchasima, Loei and Chumphon provinces.

Bee products: Bee products consist of honey, pollen, royal jelly, wax and broods with the total farm values of about 1,269 million THB (37.7 million USD) in 2013-2014 (Table 1). The major honey products are longan honey,

lychee honey and white snakeroot honey. Among these three, longan honey has the highest volume with high quality and high price. The minor honey products have very small volumes with varying prices. Other bee products also have a small volume but the prices are quite high especially the royal jelly (Table 1). Honey was exported mainly to Germany, Taiwan and Saudi Arabia with the value of 577 million THB (17.1 million USD) in 2012 (Department of Agricultural Extension, 2014).

Food Sources: Food sources of European honeybees consist of 3 groups of crops. The first group is for nectar source only, the key crops are lychee, rambutan, para rubber and Siam weed. The second group is for pollen source only. The key crops are corn, giant mimosa and sensitive plant. The third group is for both nectar and pollen sources. The key crops are longan, sesame, sunflower and kapok (Table 2).

Table 2. Key crops providing nectar source and pollen source for European honeybee.

Key crops	Nectar source	Pollen source
American rope: Mikania micrantha (L.) Kunth	+	-
Coffee: Coffea arabica L.	+	-
Corn: Zea mays L.	-	++
Giant mimosa: Mimosa pigra L.	-	++
Kapok: Ceiba pentandra Gaertu.	+	-
Longan: Euphoria longan Stend.	++	++
Lychee: Lichi chinensis Sonn.	++	-
Para rubber: Heavea brasiliasis Muell	+	-
Rambutan: Nephelium lappaceum L.	++	++
Romerillo: Bidens alba DC.	+	+
Sensitive plant: Mimosa invisa Mart ex Colla	-	+
Sesame: Sesamum indicum L.	++	++
Sunflower: Helianthus annuus L.	+	+
Siam weed: Eupatorium odoratum L.	++	-

Remarks: Information from beekeepers, bee researchers, bee experts and modified from Kongpitak, 2004

[++ = more important, + = less important]

Table 3. Key crops with their distribution in different provinces.

Key crops	Provinces
American rope	Chiang Mai, Chiang Rai
Coffee	Chiang Mai, Chiang Rai
Corn	Chiang Mai, Chiang Rai
Giant mimosa	Chiang Mai, Chiang Rai
Kapok	Chiang Mai, Chiang Rai
Longan	Tak, KhonKaen, Nakhon Ratchasima, Chiang Mai, Chiang Rai, Lamphun, Lampang,Phayao, Phrae, Nan
Lychee	Chiang Mai, Chiang Rai, Phayao, Samut Songkhram
Para rubber	Chiang Rai
Rambutan	Rayong, Chanthaburi
Romerillo	Chiang Rai
Sensitive plant	Chiang Mai, Chiang Rai
Sesame	Lopburi, Nakhon Sawan
Sunflower	Lopburi, Saraburi
Siam weed	Chiang Mai, Chiang Rai, Loei

Remarks: Information from beekeepers, bee researchers and bee experts.

European honeybee is distributed mainly in the Northern provinces because the key food sources are in this area. There are two types of beekeepers, the first one keeps bee colonies at the same location all the time and the second one moves bee colonies to food sources. The key crops with their distribution in different

provinces are shown in table 3. These crops are mainly distributed in the Northern provinces. The periods of the year which the key crops are available to honeybees are also important to apiculture industry. The first 3 months from January to March are the peak activity because the 2 key crops which provide high quality and big volumes of honey are available, also in December the activity is high because the availability of the wild flower, white snakeroot, which is another main source of honey. The data in this regard is depicted in Table 4.

Table 4. Periods of the year with the availability of key crops.

Month	Key crops
January	Lychee, Kapok
February	Longan, Rambutan, Coffee
March	Longan
April	Para rubber, American rope
May	Corn
June	Sesame
July	Corn
August	Corn
September	Romerillo
October	Giant mimosa, Sensitive plant
November	Sunflower
December	Siam weed

Remarks: Information from beekeepers, bee researchers and bee experts.

Problems faced by bee industry: Data depicted in Table 5 is highlighting the response of 22 beekeepers to illustrate problems they are facing to sustain bee keeping business. The leading challenges as perceived by the bee keepers were food sources (that means decreasing of flower blooming area because many areas were disturbed by some farmers) (25.56%), Tropilaelaps mite (25.56%) and pesticides (12.03%) (Table 5). Moreover, data documented in Table 6 revealed that Tropilaelaps mite (21.74%); food sources (20.29%) and pesticides (13.04%) were dominating problems as perceived by the bee experts. Furthermore, pesticides (25.00%), food sources (15.63%) and knowledge (some beekeepers have a lack knowledge about beekeeping) (12.50%) were the leading factors affecting the beekeeping industry as perceived by the bee researchers explained in Table 7. The three groups (beekeepers, bee experts and bee researchers) agree that lack of food sources and pesticides are among the top 3 problems. Only the bee researchers believe that Tropilaelaps mite is not the major problem, but the beekeepers and bee experts confirm that it is one of the 3 major problems.

Table 5. Problems in bee keeping listed in order of importance by 22 beekeepers.

Problems	Percentage
Food sources	25.56
Tropilaelaps mite	25.56
Pesticides	12.03
Predation of wasps	8.27
Marketing	6.77
Cost	6.02
Labor	5.26
Migration of bee hives	4.51
Season	3.02
Varroa mite	1.50
Honey price	0.75
Diseases	0.75

Food sources are definitely a big problem because the wild flowers are getting scarce from the reduction of forest areas so the beekeepers have to depend more on the agricultural crops. Nectar and pollen are necessary to development of honeybee colonies. According to Afik *et al.* (2006) indicate that for honeybees, protein is the most important macro-nutrient of pollen substitutes because it is largely used to feed developing larvae and young bees to provide the structural elements of muscles, glands, and other tissues. Likewise, Ma *et al*. (2015) reported that Alpha-Linolenic Acid (ALA) levels of 2-4% of the pollen substitute were optimal for maintaining the highest reproductive performance and the digestion and absorption of fatty acids in honey bees during the period of spring multiplication and ALA levels of 2-6% of the pollen substitute, improved worker bee longevity. Additionally, Chaplin-Kramer *et al*. (2014) reported that wild and honeybees in global decline, it is clear that food security is at risk. Lower yields of such crops could therefore have serious health implications. The pollination dependency of micronutrients (vitamin A, iron and folic acid.) was then calculated by dividing the amount of nutrients contained in the pollinator-dependent portion of crop yields by the amount in total yields. The results showed that dependency on pollination was around 50% for vitamin A in Thailand, north-central and south-east India, west Iran, Romania and east and south-west Australia. Pumpkin, melon and mango were important sources of vitamin A in the dependence hotspots, but there were regional variations.

Tropilaelaps mite is a major problem of beekeeping in Thailand.

Table 6. Problems in bee keeping listed in order of importance by 11 bee experts.

Problems	Percentage
Tropilaelaps mite	21.74
Food sources	20.29
Pesticides	13.04
Labor	8.70
Varroa mite	8.70
Season	7.25
Bee equipment	7.25
Cost	4.35
Diseases	4.35
Marketing	2.89
Bee eaters bird	1.44

Table 7. Problems in bee keeping listed in order of importance by 4 bee researchers.

Problems	Percentage
Pesticides	25.00
Food sources	15.63
Knowledge	12.50
Marketing	9.38
Diseases	9.38
Season	6.25
Bee variety	6.25
Tropilaelaps mite	6.25
Varroa mite	6.25
Predation of wasps	3.11

According to Lea (2015) from The National Bee Unit National Agri-Food Innovation Campus in UK reported that Tropilaelaps mites are mobile and can readily move between bees within the hive. However, to move between colonies they depend upon adult bees for transport through the natural processes of drifting, robbing, and swarming. Mites can spread slowly over long distances in this way. They are also spread within apiaries through distribution of infested combs and bees through beekeeping management. However, movement by the beekeeper of infested colonies of A. mellifera to new areas is the principal and most rapid means of spread. Before moving your bees it is essential to check that they are healthy. Apis mellifera colonies heavily infested with either Tropilaelaps or Varroa show similar damage. Pesticides are mentioned by the beekeepers, bee experts and bee researchers as one of the major problems. According to Fyg (1961) and Niño *et al*. (2011) stated that the climate, temperature, humidity, pesticides and other toxic substances have a high impact on all the above-mentioned characteristics. All these desired traits have a genetic basis and queens can be selected for them, but it is fundamental to consider the environmental conditions too. The latter influence, not only the development of the colony, but also the quality of queens and sperms produced by the drones. Most of the 216 primary research studies were conducted in Europe or North America (82%), involved the neonicotinoid imidacloprid (78%), and concerned the western honey bee Apis mellifera (75%). Thus, little seems to be known about neonicotinoids and bees in areas outside Europe and North America because there is considerable variation in ecological traits among bee taxa, studies on honey bees are not likely to fully predict impacts of neonicotinoids on other species (Lundin *et al*., 2015).

Table 8. Pesticide spraying activities of fruit orchards.

Type of orchard	Provinces	Pesticide spraying		
		Insecticide	Fungicide	Herbicide
Longan	Chiang Mai	February, April-August, December	August, October, November	-
Longan	Chanthaburi	January-April, July-October	April-September	May-September
Lychee	Chiang Mai	January, April, May, July-October	January, March	-
Lychee	Samut Songkhram	December	-	-

More specifically, the respondents referred to the side effects or contamination resulting from non-recommended use of insecticides during the flowering season. The beekeepers try to minimize exposure by moving bee colonies from the area where pesticides are being used. Sometimes they move only 1-3 colonies into the orchard to check the impact of pesticides before moving the rest of bee colonies. Table 8 showed the pesticide spraying activities of longan and lychee orchards. In Chiang Mai, 5 longan orchards are sprayed with insecticides in February which is the same period of bee activity (Table 4), lychee orchards are also sprayed with insecticides and fungicides in January which is the same period of bee activity (Table 4). Therefore, the beekeepers have to be more careful on the management of honeybee during these 2 months. The problems facing

the bee industry are not serious and the future of the industry is still on the rise because the demand of honey and other bee products both at national and international levels is increasing and the volumes of bee products are not sufficient at present.

Development of bee pollination industry in Thailand: The main objective of beekeeping in Thailand is to produce honey and other bee products, rather than to pollinate crops. Bee pollination industry is not well developed in Thailand. The orchard owners still do not believe that the pollination by bees can increase crop yields. Some longan orchard owners even think that bees cause the dropping of longan flowers so they do not allow the beekeepers to move bee colonies into the orchards.

Longan is the main crop being pollinated by honeybees in the northern provinces. The total area of longan is 1,044,359 rais (1 hectare = 6.25 rais), this consists of 961,513 rais of in-season longan and 82,846 rais of off-season longan (Office of Agricultural Economics, 2009). Off-season longan is distributed in Doi Tao and Hod districts of Chiang Mai, Lee district of Lamphun, Pong Namron and Soi Dao districts of Chanthaburi and Tak province. The value of off-season longan in Chanthaburi exported to China each year is about 5 billion baht (Jankiaw, 2010). There is a real need of pollinators in off-season longan in Chanthaburi (Table 9). However, beekeepers do not want to move honeybee colonies into this area because they are afraid of the heavy use of pesticides. Longan orchard owners use chemicals to control the flowering stage of longan so the timings of pesticide application in each orchard are not at the same, this is very difficult for beekeepers to manage the honeybee colonies. This area is probably more suitable to use stingless bees as pollinators because they are more resistant to pesticides and they are being used to pollinate other fruit crops in this area. However, there is one beekeeper in this area who has been renting honeybee colonies to longan orchard owners for almost 10 years at the price of 50 baht / colony / season (Interview information from Atitaya, 2014).

Responsible use of pesticides: From 19 pesticide labels collected from orchards and pesticide retailers in Chiang Mai, 10 labels (52.63%) contain warning on bee safety. The warning states not to use the pesticide at the flowering stage because it is toxic to bees. These pesticides are mancozeb, methyl benzimidazole, phenylamide, chlorpyrifos, cypermethrin, chlorpyrifos+cypermethrin, abamectin, lambda cyhalothrin, methomyl, fipronil, imidacloprid, carbaryl, and glyphosate. However, the labels of cypermethrin and abamectin of some companies do not contain the warning statement. Apart from the warning statement on the labels, there are no guidelines and activities on bee safety initiated by regulatory authority. Beekeepers, bee experts and bee researchers think that pesticides are the main threat to apiculture industry. There are no officials report on the incidences of pesticide poisoning to honeybees, only sporadic media reports.

There are MRLs of pesticides used for controlling bee mites in honey set up by National Bureau of Agricultural Commodity and Food Standard (Table 10), but there are no MRLs of pesticides in other bee products.

Table 9. Level on bee pollinator requirement in fruit orchards.

Type of fruit orchard	Provinces	Level on bee pollinator requirement			
		No	Low	Medium	High
Longan	Chiang Mai	25%	0	75%	0
Longan	Chanthaburi	0	0	0	100%
Lychee	Chiang Mai	0	0	67%	33%
Lychee	Samut Songkhram	0	0	33%	67%

Remarks: Information from 15 fruit orchard owners.

Table 10. MRLs of pesticides used for controlling bee mites in honey.

Pesticides	MRLs (ppb)
Fluvalinate	50
Amitraz	200
Coumaphos	100

Future cooperation and actions: Bee experts and bee researchers believe that organizing a national meeting on pollinator safety under Croplife umbrella in cooperation with apiculture associations would be a big benefit to apiculture industry in Thailand. Bee experts can support the partnership with Croplife Asia to increase the pollinator health awareness in Thailand by promoting the activity on giving advice on the use of safe pesticides and the correct time to spray pesticides before the peak activity period of honeybees. Orchard owners and beekeepers also want pesticide companies to produce pesticides which are safe to honeybees. The local media

which can help to increase pollinator health in partnership with pesticide industry are the two newspapers, Thairath and Daily News because they have a regular column on agriculture which can deal with this subject. The magazines are Kehakaset which is a very popular magazine on agriculture and Plibai magazine which belongs to the Department of Agriculture.

CONCLUSION AND RECOMMENDATIONS

The three main problems perceived by the apiculture industry are food sources, Tropilaelaps mite and pesticides. However, these problems are not serious and the future of apiculture industry is still on the rise because the demand of honey and other bee products both at national and international levels is increasing and the volumes of bee products are not sufficient at present. Thus, both the bee industry and government should make a concerted effort in promoting bee health. The government has the scope to significantly reduce non-recommended use of pesticides during flowering season by facilitating registration of crop protection products for specialty and minor crops where risk evaluation to bee is part of the procedure, and to support a system whereby registered crop protection products are used in a manner that would avoid risk to bees.

Acknowledgement: This work was supported by CropLife Asia. The authors would like to thank Assistant Professor Dr. Apichai Daorai for his invaluable advice towards the completion of this study.

REFERENCES

Anderson, D. L. & M. J. Morgan. (2007). Genetic and morphological variation of bee-parasitic Tropilaelaps mites (Acari: Laelapidae): new and re-defined species. Experimental Applied Acarology. 43, 1–24.

Afik, O., A. Dag, Z. Kerem & S. Shafir. (2006). Analyses of avocado (Persea americana) nectar properties & their perception by honey bees (Apis mellifera). Journal of Chemical Ecology. 32, 1949–1963.

Black, J. (2006). Honeybee nutrition: review of research and practices. Rural Industries Research and Development Corporation. Canberra.

Chaplin-Kramer, R., E. Dombeck & J. Gerber. (2014). Global malnutrition overlaps with pollinator-dependent micronutrient production. Proceedings of the Royal Society B. From http://ec.europa.eu/environment/integration/research/newsalert/subscribe.htm> Accessed on 16 June 2016.

Department of Agricultural Extension. (2014). Daily News. From <http://www.dailynews.co.th> Accessed on 17 October 2014.

Fyg, W. (1961). Anomalies and diseases of the queen honey bee. Annual Review of Entomology. 9, 207-224.

Goncalves, L. S. & D. Castilhos. (2015). Application of the electronic device "BEE ALERT" for registering death of honey bees, stingless bees in general and disappearance of honey bees (CCD) in Brazil. Scientific Program Abstracts, 44th APIMONDIA International Apiculture Congress. 15-19 September, 2015. Daejeon Convention Center, Daejeon, South Korea.

Goulson, D. (2013). An overview of the environmental risks posed by neonicotinoid insecticides. J. Appl. Ecol. 50, 977–987.

Jankiaw, W. (2010). Sriracha News Center. ASTV Manager online. From <http://www.manager.co.th/Local/ViewNews.aspx> Accessed on 17 October 2014.

Kongpitak, P. (2004). Apiculture. Department of Entomology, Faculty of Agricutural, Chiang Mai University, Thailand.

Lea, W. (2015). Tropilaelaps parasitic mites of honey bees. Animal & Plant Health Agency, The National Bee Unit, National Agri-Food Innovation Campus, Sand Hutton, York, UK.

Lundin, O., M. Rundlöf, H. G. Smith, I. Fries & R. Bommarco. (2015). Neonicotinoid insecticides and their impacts on bees: A systematic review of research approaches and identification of knowledge gaps. From: http://www.ncbi.nlm.nih.gov/pubmed/26313444Accessed on 16 June 2016.

Ma, L., Y. Wang, X. Hang, H. Wang, W. Yang & B. Xu. (2015). Nutritional effect of alpha-linolenic acid on honey bee colony development (Apis mellifera L.). Journal of Apicultural Science. 59(2), 63-72.

Manning, R., A. Rutkay, L. Eaton & B. Dell.(2007). Lipidenhanced pollen lipid-reduced flour diets and their effect on the longevity of honey bees (Apis mellifera L.). Australian Journal of Entomology. 46, 251–257.

Niño, E. L., D. R. Tarpy & C. Grozinger. (2011). Genome-wide analysis of brain transcriptional changes in honey bee (Apis mellifera L.) queens expose to carbon dioxide and physical manipulation. Insect Molecular Biology. 20, 387-398.

Office of Agricultural Economics. (2009). Area of longan plantation in Thailand. From http://www.arda.or.th/kasetinfo/logan Accessed on 17 October 2014.

Potts, S.G., J. C. Biesmeijer, C. Kremen, P. Neumann, O. Schweiger & W. E. Kunin. (2010). Global pollinator declines: trends, impacts and drivers. Trends Ecological Evolution, 25, 345–353.

Sluijs, J. P., N. Simon-Delso, D. Goulson, L. Maxim, J. M. Bonmatin & L. P. Belzunces. (2013). Neonicotinoids, bee disorders and the sustainability of pollinator services. Curr. Opin. Environ. Sustainability. 5, 293–305.

Tjeerd, B., G. Smagghe, C. A. M. Gested & V. Mommaerts. (2012). Neonicotinoids in bees: a review on concentrations, side-effects and risk assessment. Ecotoxicology. 21, 973-992.

Vanbergen, A. J. (2013). The insect pollinators initiative. Threats to an ecosystem service: pressures on pollinators. Front Ecol. Environ. 11, 251–259.