

## Review Article

# Assessment of Honeybee Colonies and production status linked with the application of Agrochemicals in Ejere District, West Shoa, Oromia, Ethiopia

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**Keywords**

- Agrochemicals
- Beekeepers
- Ejere
- Honeybee
- Honey production
- Season

**Abstract**

**Background:** The agrochemical toxicity to honey bees is a serious problem when there is contamination of hive products and environments which perish honey bee colonies due to different agrochemicals like pesticide exposure. However, little is known about the side effect of agrochemicals in Ethiopia, particularly in the study area. Therefore, the aim of this study was to assess honeybee colony and production status linked with the use of agrochemicals.

**Methods:** A cross-sectional questionnaire survey was conducted from November 2017 to March 2018 on 130 purposively selected farmers of Ejere district of West Shoa zone to assess honeybee colony and production status linked with the use of agrochemicals.

**Results:** From a total of 130 respondents interviewed, 97.7% of them believed with decreasing of their bee colonies. Majority (99.2%) of the farmers were utilizing different agrochemicals to prevent and control crop pests, weeds, rust and house pests. However, the colony status was not significantly ( $P > 0.05$ ) different across education level, awareness and age of bee keepers. Only 6.9% of the respondents had ever attended trainings on honeybee poisoning ways.

**Conclusions:** Application of different agrochemicals like pesticides were highly practicing in the study area and which situations shown to affect the colony of honeybee and production. Thus, an urgent intervention is required to mitigate challenges encountering to honeybees and production resulting from the use of chemicals.

**INTRODUCTION**

Honey bees play an important role in global food production, contributes significantly to income generation for farmer and apiary farms by bee product and by-products which improves livelihood of people. Beekeeping has no impact on the environment and help in retrieving degraded lands and increase biodiversity [1].

With wide climatic variability and unique flowering plants, Ethiopia is one of the highly suitable countries for beekeeping. The country sustains about 10 million bee colonies which about 1.8 million farmers are engaged [2]. Ethiopia has the potential to produce 500,000 tonnes of honey per year and 50,000 tonnes of beeswax per annual, but currently production is limited to 43,000 tonnes of honey and 3,000 tonnes of beeswax [3]. In Ethiopia beekeeping is characterized mainly by forest beekeeping that is common in forest covered area and back yard beekeeping which is practiced in majority of the country [4].

Agrochemicals (i.e. pesticides) are a class of chemicals or

biological agent which is used to kill or limit pests and weeds [5]. The introduction of pesticide in Ethiopia to control agricultural pest dates back to the 1960's [6]. Using agrochemicals is widely spread following modern agriculture and areas with high crop framing parts of Ethiopia are yearly receiving different types and amounts of pesticides.

Agrochemicals toxicity to honey bees is a serious problem when there is contamination of hive products and environments which perish honey bee colonies due to pesticide exposure. Most honeybee losses from 1966–1979 were attributable to organochlorine, carbamate, organophosphorus and pyrethroid pesticide exposure [7]. Colony losses were especially severe from 1981 to 2005 with a drop from 4.2 million to 2.4 million [8] although some of the decrease is attributable to changes in how colony numbers were estimated.

Genetically honeybees are sensitive to different agrochemicals (e.g. pesticides) relative to other insect genome, which they are markedly deficient in the number of genes encoding detoxification enzymes including cytochrome (p450)

monooxygenase (p450s), Glutathione-S-transferases and carboxylesterases [9]. The available information on the side effect of different agrochemicals in Ethiopia is little and incomplete [10,11]. Therefore, the purpose of this study was to provide quantified information related with the effects of agrochemicals on honeybees and their products.

## MATERIALS AND METHODS

### Description of study area

The diagnostic survey was conducted from November 2017 to March 2018 in Ejere district (Figure 1). Ejere district is bordered by Walmaraa district to the East, EjersaLafoo district to the West, Adaa Bargaa and Meettaa districts to the North, Iluu and Alamganaa district from the south [12]. It is located at a distance of 45 km, West of Addis Ababa. It is situated at an altitude ranging from 2060 to 3085 meters above sea level with an estimated area of 56918 hectares or 569.18 Square kilometers. The area receives an average annual rainfall of 1200mm whereas the minimum and maximum daily temperatures of the area are 9 and 28°C, respectively. Mixed crop and livestock farming system is the mode of agriculture practice in the district. This district has an estimated total population of 100,905 of whom 49,562 were females and 51,343 were males. The livestock potential of the district is about 93,152 Cattle, 54,115 Sheep and Goat, 43,125 Poultry, 19803 Equines and 4,760 Bee colonies; 4121 traditional, 384 transitional and 255 modern bee hives in the district [12].

### Study design

A cross-sectional questionnaire survey was conducted to collect data from November 2017 to March 2018 in Ejere district. Bee keepers of selected PAs of Ejere district were interviewed about general information to honeybee health condition, production status, and effect of agrochemicals on their honey bees and bee products, mode of applications, type of agrochemicals they used to control pests and herbs.

### Study population

All PAs and bee keeping farmers were the source population. The selected bee keepers from selected PAs were our study population. From the district, 5 PAs i.e. Cirrii, Dhaamottu, Indoode, Kimooyye and Kusaaye was selected purposively based on beekeeping potential. From each PAs, 26 model beekeeping farmers were selected and therefore, a total of 130 bee keepers were interviewed.

### Sample size determination

The required sample size (n) for this study was determined by using the following formula recommended by Arsham [14]. Thus,

$$n = 0.25/SE^2, \text{ Where,}$$

n = required sample size,

SE = the standard error.

A SE of 5% is considered for the determination of the sample size. Accordingly, 100 sample household were calculated however, the sample size was maximized to 130 in order to increase the precision.

### Data collection

A semi-structured questionnaire was administered to Ejere district to collect information's regarding demography, honeybee and production status, effect of agrochemicals on their honey bees and bee products, mode of applications, type of agrochemicals and others.

### Data analysis

The collected data was checked for completeness, cleaned and entered in to a Microsoft excel sheet. The analysis was made using SPSS statistical software package version 20. Descriptive statistics was used to determine the status of honeybee colonies

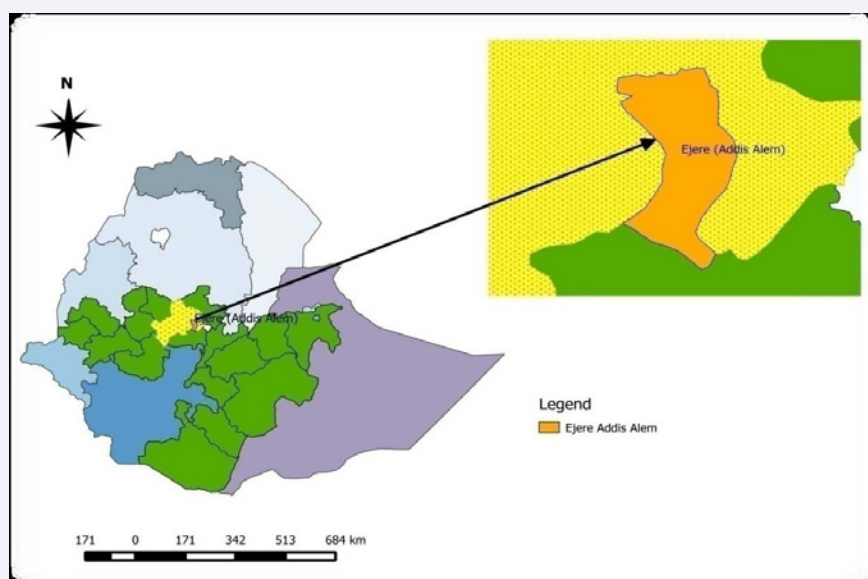


Figure 1 Map of Ejere district. Source: Segni [13].

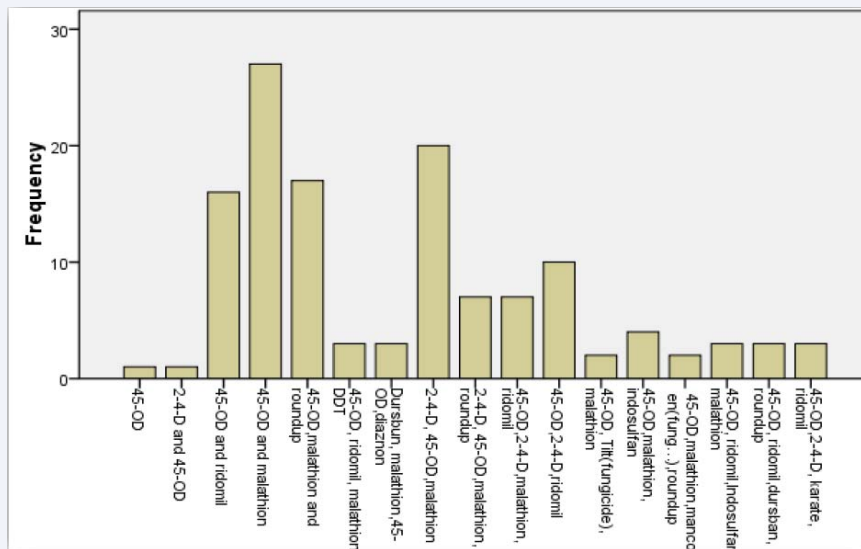


Figure 2 Agrochemicals used in the study area.

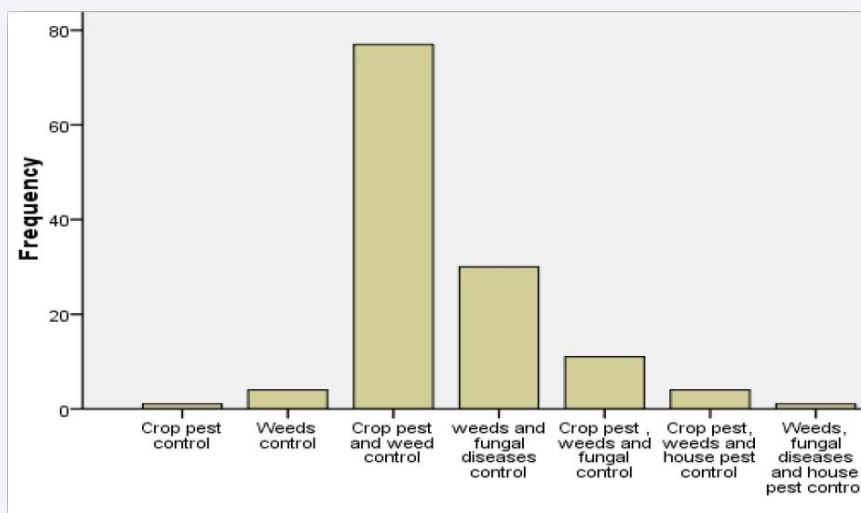


Figure 3 Purpose of agrochemical application.

and production, awareness of the respondents and their practices related to pesticide. Fisher's exact test was used to evaluate the statistical significance. P-value less than 0.05 (at 5% level of significance and 95% CI) was considered as significant in all analysis.

## RESULTS

### Demographic characteristics

From the total of 130 households interviewed, 93.8 % were male and 6.2 % female. The survey result showed that majority (51.5%) of respondent's age engaged in beekeeping activities was found between 25-40 years. Concerning to the educational status of respondents, (4.6 %) were illiterate, 83.8% attended primary school, (10.8%) of them completed secondary school and (0.8%) were high institutional graduate (Table 1).

### Purpose of honey production, colony status and owners' practices

The survey result indicates that the major family income was crop production, from livestock and in little case from honey production. Among the respondents interviewed, 98% reportedly harvest good honey from modern beehives and left 2% from transitional beehives. Among study participants' bee colonies found were 71.6% in traditional hives, 4.5% in transitional and 23.9% in modern hives (Table 2).

Respondents were asked for the reason why they need to keep honeybees and they describe that they keep for honey production and wax. Accordingly, 88.5% of respondents reported for honey production and the rest 11.5% keep for both honey and wax production. Twenty-five (19.2%) of respondents described to use honey for household, 80% for both household and sale to

**Table 1:** Demographic characteristics of study participants

Variables	Category	Frequency	Percent (%)
Age of respondents	<25	3	2.3
	25-40	67	51.5
	41-55	58	44.6
	>55	2	1.5
Sex	Male	122	93.8
	Female	14	6.2
Education level	Illiterate	6	4.6
	Primary	109	83.8
	Secondary	14	10.8
Marital status	College/University	1	0.8
	Married	129	99.2
	Single	1	0.8

**Table 2:** Source of income, bee keeping experience, type of hives and bee colony number.

Variables	Category	Frequency	Percent (%)
Source of income	Crop	4	3.1
	Crop & livestock	119	91.5
	Crop, livestock & Bee keeping	7	5.4
Producing good honey production from	Modern hives	50	98.0
	Transitional hives	1	2.0
Number of bee colonies	Modern hives	142	23.9
	Transitional hives	27	4.5
	Traditional hives	426	71.6

**Table 3:** Purpose of beekeeping and perception of beekeepers towards beekeeping.

Variables	Category	Frequency	Percent (%)
Purpose of keeping honey bees	Honey production	115	88.5
	Honey and wax	15	11.5
Purpose of honey production	For sale	1	0.8
	For household	25	19.2
	Both	104	80.0
Honey bee colony status	Decreasing	127	97.7
	Not decreasing	3	2.3
Do you use any agrochemicals	Yes	129	99.2
	No	1	0.8
Any training on honey bee poisoning	Yes	9	6.9
	No	121	93.1

get cash income and 0.8% for sale only. Those respondents asked whether their honey bee colony was decreasing or not and 97.7% of respondents agreed with decreasing of their colony (Table 3).

### Major agrochemicals used in the study area

Pesticides used in study area are herbicide (45-OD (Pallas),

2,4-D, U-46. roundup), fungicide (ridomil), insecticide (malathion, diaznon, dursban, karate, tilt, baylathone). As survey indicates these chemicals are used mainly to control weeds, crop pests, house pests and fungus (rust). Among agrochemicals, 45-OD and malathion were commonly used for weed and crop pest control, respectively in study area (Figure 2 and 3).

**Table 4:** Effect of agrochemicals toward the wellbeing of honeybees.

Variables	Frequency	Percent (%)	$\chi^2$	P-value
Do you use any agrochemicals				
Yes	129	99.2	10.167	0.023
No	1	0.8		
Any training on honey bee poisoning				
Yes	9	6.9	0.228	1.000
No	121	93.1		
Age of study participants				
<25	3	2.3	3.019	0.642
25-40	67	51.5		
41-55	58	44.6		
>55	2	1.5		
Education level				
Illiterate	6	4.6	6.240	0.183
Primary	109	83.8		
Secondary	14	10.8		
College/University graduate	1	0.8		

The survey result indicate that spraying agrochemicals have a significant ( $P < 0.05$ ) effects on the decrement of honeybee colonies. However, the declining of bee colonies was not significantly ( $P > 0.05$ ) related with the education level, awareness and age of bee keepers.

## DISCUSSION

From the total of 130 respondents interviewed, 93.8% were male and 6.2% female. Limited female numbers in keeping honeybees in this study could be due to social norms as honey bee keeping is accepted as duty of males that is agrees with Segni [13], Mujuni *et al.* [15], Dabessa and Belay [16].

The current survey result indicates that about 51.5% of respondents' age was found between 25-40 years which show highly productive age engage in honey bee keeping. This result is in agreement with findings of Dabessa and Belay [16] and Challa [17] in which beekeeping performed by economically active age groups.

In this study, majority of the respondents (83.8%) who had been engaged with beekeeping were attended elementary school. The study result agreed with the findings of Tessega [18] in which most of the respondents were capable of read and write in his study area (Burie district of Amhara region). As Mujuni *et al.* [15] and Workineh [19] reported, education increases the access to information and thereby possible knowledge of beekeepers regarding modern hive and is an important factor which if lacking can negatively impact on future improved beekeeping and adopting new technologies. However, our result disagrees with the findings of Dabessa and Belay [16], who reported 42.9% of beekeepers in Oromia special zone Walmaraa district, were unable to read and write.

Our finding revealed that most (99.2%) of the household heads were married and live with their family and engage in beekeeping regardless of marital status. The current survey result is in accordance with Tsegaye [20] who reported, 95.8% were married and irrespective of their marital status, they have been observed to undertake beekeeping activities in the South

Wollo and Waghimra zones.

In the study area, the major family incomes were from crop production and livestock farming. However, about 80% described that, beekeeping activity was used as another source of income for immediate expenses and home consumption. Dabessa and Belay [16] also reported that farmers mentioned to gain high income from honey production. According to the finding of Tsegaye [20], 94.8% of respondents noted that beekeeping activity was taken as a source of income.

In our study, 88.5% of farmers reported to keep honey bees for honey production and (11.5%) for both honey and wax extraction. Majority (71.6%) of honeybee colonies were kept in traditional hives, which is in agreement with the findings of Tsegaye [20] who reported (74.02%) of bee colonies kept in traditional hives in South Wollo and Waghimra zones. This shows that the number of honeybee colonies in traditional hives is higher compared to the modern and transitional hives in the study area. Furthermore, Segni [13] documented that traditional hives were the leading (80%) hive type practicing in the same study area.

In this study, about 97.7% of respondents agreed with decreasing of their bee colonies which is in line with reports of Dabessa and Belay [16] who reported (94.24%) respondents declared to decreasing their bee colonies and products from time to time due to threatening factors at Walmaraa district. The respondents have identified that major threatening factor at study area were agrochemicals, diseases and pests, management problem and climate change. Application of agrochemicals was significantly associated with honeybee colony decrement ( $P = 0.023$ ). The present finding come to an agreement with the results of Keralem, Tessega and Tsegaye [18,20,21] who reported the decreasing trend of honeybee populations and their products in Enebse and Bure districts and South Wollo and Waghimra zones, respectively due to pesticide and herbicide application, management and diseases.

Major agrochemicals used in study area were herbicide (45-OD (Pallas), 2,4-D, U-46, Roundup), fungicide (Ridomil), pesticide



(Malathion/Ethiolathion 50%, Diazon, DDT, Dursban 48% EC, Karate, Endosulfan, Tilt, Baylathone). Similarly, Tsegaye [20] reported that Malathion, DDT, Mancozen, Karate, Endosulfan and Diazon were the most used pesticides in South Wollo and Waghimra zones and Desalegn [22] also reported that Ethiothoate 40%, Agrothoate 40%, Diazion 60% EC, Dimethoate 40%EC, Ethiolathion 50% EC or Malathion, Karate 5EC, 2,4-D Amine, Zura, Diazion60% EC and roundup were the most used pesticides in the western Amhara.

According to this survey result, about 93.1% of respondents do not have awareness concerning safe utilization and handling of agrochemicals. This result confirms the work of Desalegn [22]; most of pesticide users have no knowledge on safe application of pesticides. As a result, pesticides and other agrochemicals might be causing considerable effects in killing honeybees and decline their products.

## CONCLUSION AND RECOMMENDATIONS

The current study results indicate that honey bee colony and production are affected by agrochemicals. In the study area, farmers are applying different agrochemicals to control pests, weeds and fungi. As a result, agrochemicals have caused huge effects in killing honeybees and decreasing their products. Utilization of agrochemicals is identified as possible factor influencing wellbeing of honeybees. Majority of the respondents had never attended on any trainings concerning honeybee poisoning. Therefore, awareness creation and generating baseline information on the mitigation of honeybee vulnerability to agro-chemicals is highly recommended. In addition, concerning stakeholders should consider towards training of farmers on safe and proper application of agrochemicals and how to protect their honey bee colonies from agrochemical poisoning and other related problems.

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## REFERENCES

1. Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, et al. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society of London B: Biological Sci.* 2007; 274: 303-313.
2. Ethiopian News Agency (ENA). Ethiopia to Enhance Apiculture. 2012.
3. Ministry of Agriculture and Rural Development (MoARD). Livestock Development Master Plan Study: Phase I Report, Volume N -Apiculture. Addis Ababa, Ethiopia. 2008.
4. Nuru A. Atlas of pollen grains of major honeybee flora of Ethiopia. Holeta Bee Research Centre. Commercial Printing Enterprise. Addis Ababa, Ethiopia. 2007; 152.
5. Marion and Bethany. Assessing the Risks of Honeybee Exposure to Pesticides. *American Bee Journal* and in *Bee Culture* 2011.
6. EPA. Federal Environmental Protection Authority, Environmental Impact Assessment Guideline on Pesticides, Addis Ababa, Ethiopia. 2004.
7. Atkins EL. Injury to honey bees by poisoning. *The Hive and Honey Bee, Revolution* Dadant and Sons, Hamilton, IL. 1992; 1324.
8. NAS (national academy of sciences). Status of pollinators in North America, National Academy Press, Washington, DC. 2007.
9. Claudianos C, Ranson H, Johson RM, Biswas S, Schuter MA, Berenbaum MR, et al. A Deficit detoxification enzyme: Pesticides sensitivity and environmental response in the honey bee. *Insect Molecular Biol.* 2006; 15: 615-635.
10. Kerealem E, Tilahun G, Preston TR. Constraints and prospects for Apiculture Research and Development in Amhara region, Ethiopia. *Livestock Research for Rural Development.* 2009; 21: 10.
11. Marta ZM, Tariku JB. Beekeeping in Ethiopia: A case of agrochemical use in West Gojjam Zone. 2014.
12. Ejeree district livestock, fisher's and rural development office (EDLFRDO) annual report. 2014.
13. Segni S. A Diagnostic Survey of Honey Production System and Honey Bee Disease and Pests in Ejere District, West Shoa Zone, Ethiopia. Addis Ababa University. 2017.
14. Arsham H. Questionnaire design and survey sampling. 9th edition. 2005.
15. Mujuni A, Natukunda K, Kugonza DR. Factors affecting the adoption of beekeeping and associated technologies in Bushenyi District, Western Uganda. *Livestock research for development.* 2012; 24: 1-13.
16. Dabessa J, Belay A. Survey on Major Honey Bee Pests and Predators in Oromia Special Zone Surrounding Finfine in Walmara District. *Europ J Biological Sci.* 2015; 7: 62-70.
17. Chala K, Taye T, Kebede D, Tadele T. Opportunities and challenges of honey production in Gomma district of Jimma zone, South west Ethiopia. *Journal of Agricultural Extension and Rural Development.* 2012; 4: 85-91.
18. Tessega B. Honeybee Production and Marketing Systems, Constraints and Opportunities in Burie District of Amhara Region, Ethiopia. Bahirdar University. 2009; 116.
19. Workneh A. Identification and documentation of indigenous knowledge of beekeeping practices in selected districts of Ethiopia. *Journal of Agricultural Extension and Rural Development.* 2011; 3: 82-87.
20. Tsegaye A. Potential Threats to Honeybee Health with Emphasis on Varroa mite in South Wollo Zone of Amhara Region. Bahir Dar University. 2015.
21. Kerealem E. Honeybee production system, opportunities and challenges in EnebseSarMidirWoreda (Amhara Region) and Amaro Special Wereda (Southern Nations, Nationalities and peoples Region), Ethiopia. Haremaya University. 2005; 133.
22. Desalegn B. Assessment of Pesticides Use and its Economic Impact on the Apiculture Subsector in Selected Districts of Amhara Region, Ethiopia. *J Environmental and Analytical Toxicol.* 2015; 3: 1.

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## APPENDIX

### Annex 1. Semi-structured questionnaire

#### General information

1. Respondent name \_\_\_\_\_ Sex \_\_\_ Age: A. <25 B. 25-40 C. 41-55 D. >55
2. Level of education: A. Illiterate B. Primary C. Secondary D. College/University graduate
3. Marital status: \_\_\_\_\_
4. Major source of your income is/are: \_\_\_\_\_
5. Agro-ecology: i, Highland (Dega) ii, Mid highland (woinadega) iii, Lowland (Kola)
6. Vegetation types found in your area: A. trees B. shrubs C. herbs D. Others (specify)
7. Do you have apiculture farm? A. Yes B. No
8. If yes, which type of hives do you have? A. traditional B. modern C. transitional
9. How many colonies (hives) do you have currently? Traditional\_\_? Modern\_\_? Transitional\_\_?
10. For what purpose do you keeping honeybees? A. Honey production B. Beeswax  
D. Bee brood E. both honey and wax production
11. From which type of hive do you get better honey production? A. Traditional  
B. Modern C. Transitional.
12. From which type of hive do you get high wax production? A. Traditional  
B. Modern C. Transitional.

#### II. Agrochemicals effect toward the wellbeing of honey bees

Do you believe that the number of honey bee colonies are decreasing? A. Yes B. No

If your answer is "yes" what do you think the reason(s)? A. agrochemical effect B. disease and Pests C. management problems  
D. Climate change

Does the honey quality and production is decreasing in your locality? A. Yes B. No

If "yes", what is/are the reason(s) behind? A. Effect of chemical poisonings B. diseases and Pests C. Processing and post harvest  
management problems D. other factors (specify)

Do you use any agrochemicals for agricultural purpose? A. Yes B. No

If yes, for what purpose (specify)? \_\_\_\_\_

When did you use chemicals (seasons)? \_\_\_\_\_

Which type of agro-chemicals did you applying?

Do you have any information on side effect of agro-chemicals toward the honey bees? A. Yes B. No

Have you ever attended on any trainings concerning side effect of agro-chemicals toward the honey bees? A. yes B. no