

# Side Effects of Agro-chemicals on Beekeeping in East and West Gojjam Zones of Amhara Region, Ethiopia

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**Abstract:** The study was conducted in West and East Gojjam Zones of Amhara Region Ethiopia to determine commonly used agro-chemicals and timing of applications, their effects on honeybee by itself and beekeeper farmers used cultural practices to minimize agro-chemical side effects on honeybee; Questionnaire survey methods, key informants interview and focus group discussion were used for the study. In the questionnaire survey, 384 respondent beekeepers from 4 Woredas, 20 Kebeles (376 male and 8 female) were interviewed. Descriptive, frequency with SPSS version 20 were used. The majority of farmers spray herbicides before blooming in August and insecticides at diseases and pests observed in October, November and December. Surprisingly, almost all respondents interviewed (98.7%) have confirmed that they know the negative effects of agro-chemicals on the health status and life of the honeybee. Apparently pesticides have been causing considerable damage by killing honeybees and causing yield decline due to miss use of agrochemicals. 90.9% of the non-beekeepers who use agro-chemical had no willingness to use non-chemical or alternative mechanisms to control pests and weeds. The main reported reason for the non-beekeepers not informing others about their plan to apply agro-chemicals is their laziness and jealousy; only 8.1% of respondents have willingness to use non-chemical or cultural weed and pest control mechanisms to save honeybee colonies as well as to keep their farmlands as organic. Overall the level of cooperation between beekeepers and non-beekeepers with regard to responsible use of agro-chemicals is very weak and certainly not considerate of mutual benefits and environmental protection. Essential to capacitate beekeepers in terms of technical knowledge and skills to better manage and need concerted action to develop appropriate agro-chemical application modalities that minimize side effects on honeybees and economic losses would be recommended.

**Keywords:** Agro-chemicals, Cultural Mechanism, East Gojjam, West Gojjam

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## 1. Introduction

Ethiopia is one of the countries in the continent, with huge honey production potential owing to its varied ecological and climatic conditions. Ethiopia is home to some of the most diverse flora and fauna in Africa [1].

Beekeeping is economically important activity that generates income for millions of people in Ethiopia and the world at large. Bee keepers earn income from direct sale of hive products such as bee colony, honey, beeswax, propolis, royal jelly and from products made up of honey and beeswax

like honey beer, candle waxes, polish and cakes [3]. Beekeeping remains to be one of the most profitable areas in the agricultural sector which has not been exploited yet to its full potential [3].

It is estimated that the country has the potential to produce 500,000 tons of honey per annum [10]. The recent production, however, is 53,675 tons of honey [7]. In Amhara Region, Beekeeping is a deep-rooted household activity and an integral part of the life style of the farming communities documented to own more than 1,328,235 honeybee colonies [7]. During the production season the Amhara Region has produced about 9,925 tone of honey [7]. The above figure

shows that the country is producing less than 10% of its potential.

Agro-chemical poisoning by pesticides and herbicides are also serious constraints to bee keepers [14]. Apparently pesticides have been causing considerable effects in killing honeybee and thereby product decline [8]. On average, 1,736, 4036 and 1,890 honeybee colonies are dying, absconding and dwindling, respectively every year from Mecha, Dangila and Guangua districts of West Gojjam Zone of Amhara Region [8]. The most used brands of pesticides are Malathion 50%, phenetratite 50% Ethiothoate 40%, Agrothoate 40%, Diazion 60% EC, Dimethoate 40% EC, Ethiolathion 50% EC or Malathion, Karate 5EC, and herbicides like 2, 4-D Amine, Zura, Diazion 60% EC, Agro- Thoate 40%, Etho-Thoate 40%, Heptachlors, Phenetratite 50%, Daconil, Diasnol, Primagram, Roundup, Agroset, Glycell and Terminator [8].

This study sets out to look at major reported honey bee diseases, pests and predator *species* as well as uses of agro-chemicals and their effects on honeybees in East and West Gojjam Zones.

The identification and severity of each economically important agro-chemical effects on honeybee have not been well documented in the study area; hence there is little information available about them. To fully exploit the opportunities in beekeeping sector, addressing the constraints and effects of agrochemicals on honeybee's health problem and beekeepers cultural control mechanisms during spray are key steps to prevent their harmful effects.

Therefore, the study was carried out aiming to assess effects of agro-chemicals on honeybee and documented beekeepers' cultural practices in managing these problems in the study areas: with the specific objectives:

1. Identify type and timing of applications of most commonly used agro-chemicals
2. Identify common cultural practices applied to manage honeybee infected by agro-chemicals application.

## 2. Methodology

The study was conducted in West and East Gojjam Zones of the Amhara National Regional State of Ethiopia in the four YESH project "*Woredas*" (Bure Zuria, Dembecha zuria, Awabel and Hulut-Eju Enessie). The study "*Woredas*" were therefore selected purposively for being the project areas and commercial farmed bee keeping has been promoted by the project.

### 2.1. Study Area Description

#### 2.1.1. Burie Zuria "*Woreda*"

Burie Zuria "*Woreda*" is located in West Gojjam Zone of the Amhara National Regional State in North-Western Ethiopia. The "*Woreda*" is approximately located between 10°17'-10°45'N latitude and 37°00'-37°10'E longitude. Burie town, its capital, is located North-West of Addis Ababa at a distance of 410 km on the main highway through Debre Markos to Bahir Dar. It is bordered on the south by Blue Nile (Abay) River which separates it from Oromiya Region; on

the west by Wemberma *Woreda*, on the northwest by the Agew-Awi Zone, on the north by Sekela *Woreda*, on the east by Jabi-Tehnan *Woreda*, and on the southeast by Dembecha and Misraq Gojjam Zone. The altitude of the *Woreda* varies from 1,500 - 2,400 masl. Before the establishment of the current Burie town administration, Burie "*Woreda*" had 18 rural, 4 semi-urban and 5 urban Kebeles with a total area of 838.9km<sup>2</sup> land, inhabited by overall human population of about 175 thousand; its livestock population consists of 90,475 cattle, 52,304 sheep, 13,523 goats, 6,716 donkeys, 620 horses, 228 mules and 10,499 honeybee colonies.

Topography of the *Woreda* is estimated to be 76% plain, 10% mountainous, 7% undulating, and the rest 7% valley [4]. The three traditional agro-ecological zones found in Burie "*Woreda*" are mid-land (77.2%), semi-lowland (21.8%) and highland (1%). The mean daily temperature ranges from 17 to 25°C; and elevation ranges from 700 masl in the Abay gorge to 2350 masl at Jib-Gedel Kebele in the highlands. The annual rainfall pattern was mono-modal starting from June to September which receives annual rain fall of 1,000 to 1,500 mm.

The plain topography combined with the availability of optimum climatic and fertile soil condition makes the "*Woreda*" suitable for mixed crop-livestock production. Cultivated land, shrub land, and grazing land account for about 36.3%, 27.6%, and 17.1%, respectively, of the total area of the district [6]. The farming system of the "*Woreda*" was categorized to the mixed crop-livestock production system; the farmers used their land mainly for cropping purpose. Annual crops maize, wheat, hot pepper and millet, were the top four major crop types widely produced in the "*Woreda*", and more specifically the majority of maize and wheat production is comes from sub-lowland agro-ecology [4].

#### 2.1.2. Dembecha Zuria "*Woreda*"

Dembecha is a town in northwestern Ethiopia 350 km north of Addis Ababa located in the West Gojjam Zone. This town has a latitude and longitude of 10°33'N37°29'E with an altitude elevation range of 1,500 to 2,995 meters above sea level. Dembecha Zuria "*Woreda*" is bordered on the west by Burie Zuria, on the northwest by Jabi Tehnan, on the north by Dega Damot, and on the east and south by the East Gojjam Zone. Towns in Dembecha Zuria include Addis Alem, Dembecha and Yechereka. The "*Woreda*" had 25 rural and 4 urban Kebeles with a total area of 97,926 hectares of land inhabited by an overall human population of about 157 thousand and livestock population of 133,227 cattle, shoat 58,477, equines 20,053, hen's 101,351 and 12,058 honeybee colonies. The three traditional agro-ecological zones found in Dembecha zuria "*woreda*" are low-land (11%), mid-land (83%) and highland (6%). The annual average rain fall is 1,006 mm and average annual temperature of 23°C.

#### 2.1.3. Description of Awabel "*Woreda*"

Awabel "*Woreda*" is located in East Gojjam Zone. Its approximate coordinates are 10°15' N latitude and 37°56' E longitude. Lumamie, the "*Woreda*" capital, is located north west of Addis Ababa at a distance of 257 km on the main highway through Dejen leading to Bahir Dar. It is bordered

on the south by the Abay River which separates it from the Oromia Region, on the west by Aneded *Woreda*, on the northwest by Sinan *Woreda*, on the northeast by Debay Telatgen *Woreda*, and on the east by Dejen. The “*Woreda*” has 28 rural and 3 urban Kebeles with a total area of 742.9 km<sup>2</sup> inhabited by an overall human population of about 176 thousand. Its livestock population includes 219,459 cattle, shoats 98,478, equine 38,786, chicken 42,957 and 8,356 honeybee colonies. The three traditional agro-ecological zones found in Awabel “*Woreda*” are mid-land (60%), semi-low land (25%) and highland (15%) with average altitude of 2,290 masl. The annual rainfall pattern is mono-modal extending from June to September ranges from 1,100 to 1,400 mm with average 1,250 mm and annual average temperature of 22.5°C which ranges from 19°C to 26°C.

#### 2.1.4. Hulet Eju-Enesie “*Woreda*”

Hulet Eju-Enesie is approximately located 11°4'N latitude and 37°52'E longitude. Part of the East Gojjam Zone, it is

bordered on the south by Debay Telatgen *Woreda*, on the west by Bibugn and Goncha *Woreda*, on the north by the Abay River (which separates it from the South Gondar Zone), on the east by Goncha Siso Enese district, and on the southeast by Enarj Enawga district. The towns in the *Woreda* are Keraniyo, Mota and Sede.

It has 44 rural and 4 urban Kebeles with a total area of 154.802 hectares, inhabited by an overall human population of about 290 thousand and livestock population of 158,486 cattle, 95,144 sheep, 52,137 goats, 14,902 equines, 109,828 hens and 14,601 honeybee colonies. The three traditional agro-ecological zones found in Hulet ejunesie *Woreda* are low-land (12%), mid-land (64%) and highland (24%) with elevation range of 1,200 to 2360 masl. The annual rainfall pattern is mono-modal spread from June to September, ranging from 800 to 2,500 mm with average of 1,650 mm. It's annual temperature of 26°C c ranging from 13°C to 33°C.

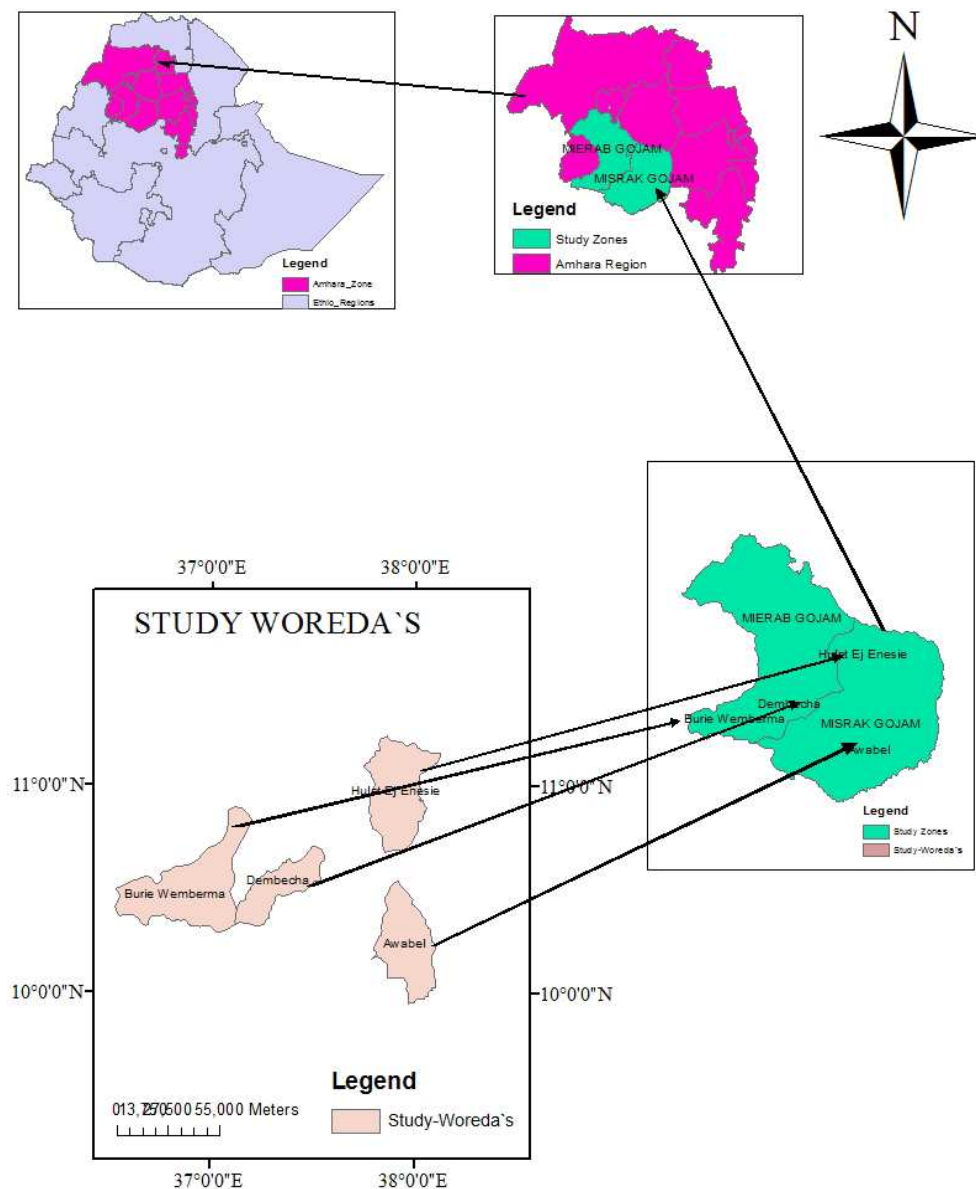


Figure 1. Map of study area.

Regional distribution of honeybee colony in Ethiopia is higher in Oromiya Region (55%) followed by Amhara Region (19.35%) from the total honeybee colonies found in

Ethiopia, which is distributed in each Zone of Amhara Region (Table 1).

**Table 1.** Amhara Region honeybee colony zonal distribution and regional share of each zone.

Zone	Area coverage		Honeybee Resource		Honeybee colony per km <sup>2</sup>
	Km <sup>2</sup>	Regional share	Honeybee colony	Regional share	
North Gonder	45,561	28.26	273,700	22.02	6.01
South Gonder	20,061	12.44	191,344	14.88	9.54
North Wolo	10,177	6.31	44,404	5.65	4.36
South Wolo	17,462	10.83	186,977	10.91	10.71
North Shewa	17,698	10.98	80,512	5.26	4.55
East Gojam	14,705	9.12	151,047	12.14	10.27
West Gojam	13,910	8.63	197,222	16.01	14.18
Waghimra	8,421	5.22	50,513	5.15	5.99
Awii	8,579	5.32	142,488	7.27	16.08
Oromiya	4,665	2.89	8,241	0.62	1.77
Total/Regional	161,239		1,328,235		8.24

Source: CSA, 2016.

## 2.2. Sampling Method and Sample Size

Before the actual survey was conducted secondary data and relevant information were collected through consulting responsible extension officers at Regional, Zonal and *Woreda* levels and baseline information on the effects of agro-chemicals on honeybee and comprehensive information about the study was collected. Based on the secondary data semi-structured questionnaires were prepared and pre-tested.

In each *Woreda* five of the YESH project operational Kebeles were selected by the project based on their beekeeping potential and experiences in beekeeping for promotion of commercial beekeeping and these same Kebeles were selected for this study.

The numbers of respondent beekeepers required and selected were 384 [15] using the following formula:

$$N = \frac{1.96^2 p_{exp} (1 - p_{ex})}{d^2}$$

Where: n= required sample size

P<sub>exp</sub> = Expected prevalence

d = Desired absolute precision

Accordingly a total of 384 respondent beekeepers were selected for a diagnostic survey used by random sampling methods and it was distributed proportionally to each of the selected kebeles. In total, 2 zones, 4 "*Woredas*", 20 rural Kebeles (five Kebeles from each "*Woreda*") were selected purposively, and 384 beekeepingfarmers from the four "*Woredas*" (100, 92, 108 and 84 from Burie Zuria, Dembecha Zuria, Hulet Eju Enesie and Awabel, respectively) were selected based on beekeeper population. First all beekeeping farmer populations were recorded in the Excel in each study Kebele and using random sampling method the study households were selected.

## 2.3. Methods of Data Collection and Data Sources

The data include both primary and secondary data. Direct observation and interviews were used to capture primary

data. Both individual interviews and focus group discussions were employed. Secondary data was collected from Regional, Zonal and *Woreda* level extension offices for livestock and fisheries development. Specific study Kebeles, NGOs, and publications were used as sources of secondary information.

### 2.3.1. Semi-structured Questionnaire

Semi-structured questionnaire was used to interview respondent beekeepers. Both qualitative and quantitative data were collected such as household characteristics, common agro-chemicals used (by crops type, season of application and their effects on honeybees), common cultural practices to manage honeybee health problems, potential constraints of beekeeping. Age and family size of the respondents, amount of agro-chemicals applied and honey harvested, and numbers of colonies owned and absconded were collected as quantitative.

### 2.3.2. Key Informants Interview and Focused Group Discussion

Key informants interviews covered experts, agro-chemical dealers, knowledgeable beekeepers, village elders. Focus group discussions (FGDs) were conducted at 5 sites per study *Woreda*, with 1 focus group discussion for each sample Kebele. The points for discussion were relative comparisons and prioritization of problems and their possible suggested or practiced solutions. Both men and women beekeepers as well as extension experts participated in the FGDs with about 8 to 12 participants in each.

## 2.4. Data Management and Statistical Analysis

The collected data was stored in Microsoft Excel spreadsheets for data management. Analysis was done using SPSS software version 20. The statistical analysis used in the study varied depending on the type of variable and information obtained. Summarized data was presented in the form of tables and figures. The questionnaire survey data was analyzed using descriptive statistics.

### 3. Results and Discussion

#### 3.1. Status of Agro-chemicals Use in the Study Areas

In this study, 88.5% of respondent beekeepers reported to be using agrochemicals in their localities for the control of weeds, pests and aphids (Table 2). This is higher than the figure reported by [1, 8] which was 82.4% and 54% from eastern Amhara and western Amhara, respectively. Our survey also

revealed that 18.2%, 84.9% and 1.6% of the respondents were using pesticides for crop protection, herbicides for weed control and chemicals (like DDT) as anti- malaria (Table 2). Virtually, 87.5%, and 1% of the respondents were applying chemicals as liquid and dust spray, respectively (Table 2). [8] reported that the majority (85%, 125 out of 147) of farmers using pesticides apply it in liquid (emulsified) form whereas 8.84% (13/147) apply it in powder form.

**Table 2.** Status and reason for agro-chemical application by the respondents in West and East Gojjam Zones.

Description	Response	Frequency	%
Do you use agro-chemical in your locality	Yes	340	88.5
	No	43	11.2
Reason why do you apply the chemical	Crop pest control	70	18.2
	Weed control	326	84.9
	Malaria control	6	1.6
	Insecticide	22	5.7
Target used	Herbicide	286	74.5
	Fungicide	4	1.0
	Both insecticide and herbicides	29	7.6
	Dust/powder	4	1.0
Agro-chemicals formulation	Liquid spray	336	87.5

#### 3.2. Agro-chemical Use by Crop Type

Different brands of agro-chemicals were listed in use by key informants and direct observations in the market. Information was cross-checked with data collected through individual interviews. The most used brands of pesticides

were Malathion, Endosalphane, Manchosave, Rodomel, Diazinone, Dimethoate and herbicides like 2, 4-D, Helosate 48SL/Round up/, chapamine 720 SL, Primagram, Roundup and Agroset. This list is similar with the list by [8, 9].

**Table 3.** List of agro-chemicals being used for crop types in West and East Gojjam Zones.

Agro-chemicals used	Nature	Amount/hectare	Uses
Agro 2, 4-D	Herbicides	1 liter	Used for teff, wheat, barley, maize, finger millet and sorghum to kill/control broad leaf weeds
Malathion	Pesticides	2 liters	Used for control of pests and aphids on teff, “chat”, legume crops, vegetable crops and fruits
Endosalphane	Pesticides	2 liters	To control crop pests
Round up, Helosate 48 SL	Herbicides	4-5 litter	Used 14 days before ploughing to control the grass “serdo” ( <i>Cynodon genus</i> )
Rodomel	-	1 kg	To control potato diseases
Manchosave	Pesticides	2 liters	To control crop pests
Chapamine 720 SL	Herbicides	1 liters	To control weed from finger millet, teff, wheat and barley
Diazinone	Pesticide	2 liters	For the control of pests of cereals, vegetables
Primagram and Agroset	Herbicides	1 liter	Used for weed control
Dimethoate	Pesticide	2 liters	To control crop pests

#### 3.3. Amounts of Agro-chemicals Used

Respondent beekeepers reported to be using different amount of agro-chemicals for different farm land sizes and different crops. The overall average amount of herbicide used by all respondents was 0.5134 liters, per household with standard deviation of 0.40357. The reported range of values was from 0.04 to 2.5 liters per households. In terms of farm land size the overall average was 0.7988 hectare, with

standard deviation of 0.5211. The range of reported values was from 0.13 to 3 hectares (Table 4). Likewise, respondent beekeepers reported to have used an overall average of 0.5871 liters of pesticides per household, ranging from 0.05 to 3 liters, and standard deviation of 0.655. By land size, the average household reported to have covered 0.8056 hectare of farm land, with reported values ranging from 0.25 to 3.25 hectares with standard deviation of 0.72468 (Table 4).

**Table 4.** Agro-chemicals used with proportion of land size in West and East Gojjam Zones.

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Herbicide application land area in hectare	314	0.13	3.00	0.7988	0.52110
Pesticide application land area in hectare	54	0.25	3.25	0.8056	0.72468
Quantity of herbicide (Liter)	307	0.04	2.50	0.5134	0.40357
Quantity of pesticide (Liter)	55	0.05	3.00	0.5871	0.64491

### 3.4. Timing of Application of Agro-chemicals

It is clear that agrochemical application depends largely on the type and nature of the crops. According to this survey, majority (66.9%) of respondents, apply agro-chemicals before blooming this might be none of indirect effect on honeybees but, it has direct effect on honeybee while only 7.8% of them during blooming it have direct and indirect effect on honeybees, 0.5% at flowering, and 5.7% when crop pests and diseases are observed (Table 5). Whereas, only 7.3% of the respondents apply agro-chemicals both before blooming and when crop pests and diseases are observed in the field. [8] reported that 114 out of 147 pesticide users apply before blooming and only 25 have applied both before and during blooming.

Result of this survey also show that the majority of the respondents (64.6%) apply the chemicals in the morning, 15.9% of them at midday, while 5.7% of them apply in the late evening and only 2.1% of them apply at night. This means that agro-chemical application happens during the

peak honey bee foraging activities, and hence the honey bees come in contact with the chemicals and are therefore exposed to the side effects of these agro-chemicals. The same research result reported by [1] in Eastern Amhara, majority of the respondents apply agro-chemicals at early morning (67.9%) of the day and about 40.51% the respondents apply the chemicals during bees' active foraging time including late morning (14.9%), middle of the day (11.3%) and early afternoon (14.31%). Only few respondents (1.6%) were applying the chemicals at the late afternoon

Moreover, majority of the respondents (67.4%) apply agrochemicals at the end of August to control pests and diseases of *teff*, wheat and barley while 8.6%, 3.1%, 1%, and 1.3% of the respondents apply agro-chemicals in September, October, November and December, respectively. The survey has also identified that only 7.3% of the respondents apply agro-chemicals to control crop weeds and pests during September and November.

**Table 5.** Reported frequencies of application of agro-chemicals in West and East Gojjam Zones.

Variable	Category	Frequency	%
Stage of agrochemicals application	Before blooming	257	66.9
	At blooming	30	7.8
	At flowering	2	.5
	When disease and pests observed	22	5.7
	before blooming and when disease and pest observed	28	7.3
Time of agro-chemical application	Morning	248	64.6
	Middle of day	61	15.9
	Late evening	22	5.7
	Night	8	2.1
Month of agro-chemical application	August	259	67.4
	September	33	8.6
	October	12	3.1
	November	4	1.0
	December	5	1.3
	September and November	28	7.3

### 3.5. Farmers' Awareness on the Effects of Agro-chemicals

Surprisingly, almost all respondents interviewed (98.7%) have confirmed that they know the negative effects of agro-chemicals on the health status and life of the honeybee. This level of awareness is comparable with those reported by [13] who have reported 96.7% awareness on side effects of herbicides on honeybee. Respondents indicated that their awareness arose from their own experiences and information disseminated from extension services (Table 6). This is similar to the report by [1] from the eastern Amhara.

In this survey, 57.3% of the respondents have confirmed that they have observed honey bees being unconscious and dead in the field due to agro-chemical poisoning while 16.4%

of the respondents explained that they have observed the same effect inside the hive while 25.8% of the respondents observed the effects of agro-chemicals on honey bees dead inside the hive and unconscious in the field while foraging (Table 6). These agro-chemicals have direct and indirect effects on honeybees [12] who reported pesticides can pose environmental risks and exposure alone can impair the physical ability of bees to fly.

According to our results, majority of the respondents (87.5%) knows the proportion of agro-chemicals in the mixture and area coverage before application in the field. For instance, depending of the infestation level and crop type, respondents are using 1 liter of herbicide per hectare whereas they use 2 liters of pesticides per hectare to control pests.

**Table 6.** Level of awareness of beekeepers on the effects of agro-chemicals on bees in West and East Gojjam Zones.

Description	Response	Frequency	%
Are you aware of agro-chemicals effect on honeybees	Yes	379	98.7
	No	3	.8
Effects of agro-chemicals on honeybees	Inside hives	63	16.4
	In field during foraging	220	57.3
	Inside hives & field	99	25.8

Description	Response	Frequency	%
Do you know agro-chemical proportions	Yes	336	87.5
	No	42	10.9

### 3.6. Cooperation Between Beekeepers and Non-beekeepers

About 96.9% of the respondents indicated that agro-chemical users do not announce their plan before agrochemical application, and only few (2.1%) agro-chemical users inform beekeepers before agro-chemical application (Table 7). Moreover, 90.9% of the non-beekeepers who use agro-chemical had no willingness to use non-chemical or alternative mechanisms to control pests and weeds. The main reported reason for the non-beekeepers not

informing others about their plan to apply agro-chemicals is their laziness and jealousy and only 8.1% of respondents have willingness to use non-chemical or cultural weed and pest control mechanisms to save honeybee colonies as well as to keep their farmlands as organic. Overall the level of cooperation between beekeepers and non-beekeepers with regard to responsible use of agro-chemicals is very weak and certainly not considerate of mutual benefits and environmental protection.

Table 7. Reported level of cooperation between beekeepers and non-beekeepers in West and East Gojjam Zones.

Variable	Category	Frequency	%
Do agro-chemical users inform beekeeper before application?	Yes	8	2.1
	No	372	96.9
Are farmers willing to use mechanical or cultural weed and pest control after awareness?	Yes	31	8.1
	No	349	90.9

### 3.7. Reported Economic Losses Due to Application of Agro-Chemicals

According to our result, due to misuse of agro-chemicals on average  $2.66 \pm 2.48$  and  $2.99 \pm 2.53$  colonies absconded in the last two consecutive years 2015 and 2016, respectively. Whereas,  $2.84 \pm 2.93$  and  $1.60 \pm 0.97$  colonies were classified as dwindled colonies caused by misuse of agro-chemicals in these two consecutive years, respectively. Moreover, respondent beekeepers have explained that they have lost  $15.99 \pm 17.43$  kg of honey per individual beekeeper due to unwise agrochemical applications which is estimated to be ETB1, 554 $\pm$ 1,700 but ranged from ETB100 to 12,000 (Table

8). Apparently pesticides have been causing considerable damage by killing honeybees and causing yield decline [8]. On average, 1736, 4036 and 1890 honeybee colonies died, absconded and dwindled, respectively every year from Mecha, Dangila and Guangua districts of West Gojjam Zone of Amhara Region [8].

Accordingly, both honeybee colonies and economic losses by respondent beekeepers were higher in Awabel Woreda followed by Dembecha Zuria, Burie Zuria and Hulet Ejunesie Woredas. There prevails unwise or indiscriminate use of agro-chemicals in Awabel Woreda especially for leguminous crops like vetch (*Lathyrus sativus*), chickpea (*Cicer arietinum*), and bean (*Vicia faba*).

Table 8. Economic loss of beekeepers due to effect of agro-chemicals in range in West and East Gojjam Zones.

Variables	Year	N	Minimum	Maximum	Mean	Std. Dev.
Absconded colonies due to agro-chemicals	2016	122	1.00	15.00	2.6639	2.47837
Dwindled colonies due to agro-chemicals	2016	112	1.00	12.00	2.9911	2.53087
Absconded colonies due to agro-chemicals	2015	93	1.00	15.00	2.8387	2.92772
Dwindled colonies due to agro-chemicals	2015	66	1.00	4.00	1.6061	0.97474
Estimated honey loss in kg due to agro-chemical applications	2016	202	2.00	120.00	15.9901	17.42503
Estimated honey loss due to agro-chemical applications in birr	2016	204	100.00	12000.00	1554.362	1700.19242

Plants those are toxic to honeybees in the study area

In general there was no serious reported case of plant toxicity in the study area. A few plant species were reported by respondents as having some undesirable effects on honeybees. These are croton (*Croton macrostachyus*), and vernonia (*Vernonia schimperi*), which cause honeybee diarrhea and make the honeybees aggressive to the extent that they abscond. [14] reported similar finding from Burie Woreda. Sophora aurea (*Calpurnia aurea*) in Amharic “Digta”, was also identified as toxic to honeybees. Honeybees do not visit this plant and in fact beekeepers use its leave extracts as repellent on their hands so that honeybee do not land and sting their hands during

inspection. The leaves may have unpleasant smell or repellent effect on honeybees. Honeybees might also be affected by *Acacia saligna*, but this needs to be confirmed by research.

### 3.8. Cultural Practices of Beekeepers

Most (87.2%) of the respondent beekeepers did not report use of any cultural practices during agrochemical application to save their bees (Figure 2). Only some of the respondent beekeepers spray agrochemicals at recommended times when the honeybee are less active on foraging such as at night and early morning (1%); some close of the hive entrance with coarse cloth for a time being



(6.5%). Others reported to be spraying milk in the hive entrance to delay foraging times of honeybees as they tend to stay licking the milk (4.2%).

More over beekeepers use different cultural practices to control swarming colony like removal of queen cells,

smoking of mule bone and “*Etan*” (*Boswellia papifera*), catching the swarm queen with locally made queen cage locally known as “*chifchan*” and to minimize bee sting beekeepers spray or scratch or painting their hands with repellent ability plant leaves “*Digita*”

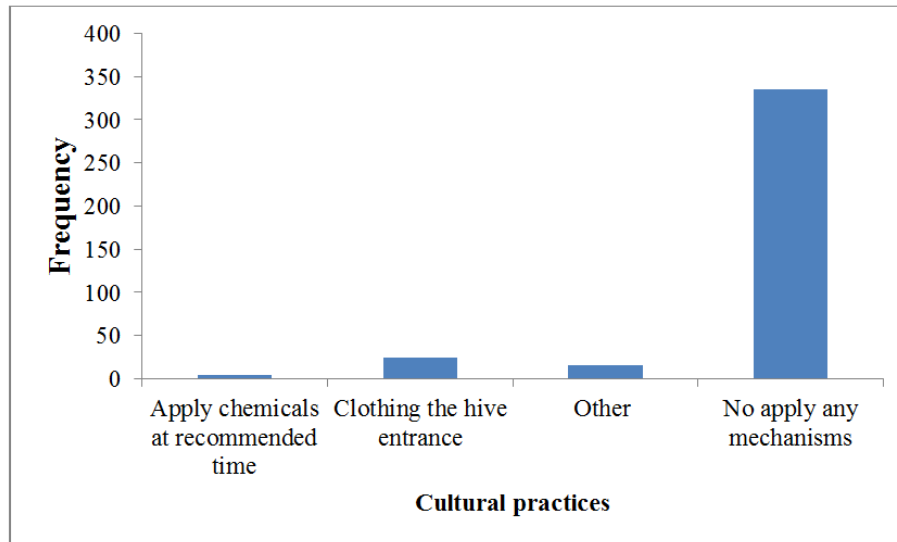


Figure 2. Reported cultural practices to protect bees during agro-chemicals application.

Table 9. Reported major enemies of honeybees and associated beekeeping practices in West and East Gojjam Zones.

Bee enemies	Cultural practices used to control effects of bee enemies
Ants	Clean apiary; place fresh ash around the hive stand; destroy nests of ants [14, 16]; placing the hive suspended on a rope.
Wax moths	Cleaning apiary; remove and clean the old combs; smoking the hive; rubbing the hive with recommended plant materials like “ <i>Besobila/Zikakibe</i> ”
Spider	Removing the web of spiders frequently; cleaning apiary
Small hive beetles	Clean apiary; narrowing the hive entrance; hand pick and kill; cover openings or cracks of hives
Praying mantis	Clean apiary; catching and killing; minimize hive entrance
Wasps	Clean apiary; removal of wasp’s nest
Bee eater birds	Killing using “ <i>wonchif</i> ”; putting teaser figure (man in cloths)
Hamagot/Shelemetemat/Honey badger	Fencing; catching using traps and killing; use hunter dog. This current research result control mechanism in line with [5] reported in Bale Zone, fencing the apiaries and killing of honey badger.

### 3.9. Beekeeping Training and Skill of Beekeepers

Technical skill and knowledge of beekeepers are the key to success in the apiculture sector; perhaps knowledge on the skill gaps and needs can be useful for designing future interventions. Only 27.3% of respondent beekeepers have attended apiculture training by public extension services 20.8% and by NGOs 5.5% (Table 10). Training types acquired by respondent beekeepers yet were on theoretical 13.5%, practical 1% and on both 10.7% (Table 10). Practical training taken by respondent beekeepers mainly on hive making 4.2%, only 0.5% both hive making and colony multiplication and 1.6% on others like colony transferring, honey harvesting and processing. Only few of respondents (8.2%) have received beekeeping equipment from NGOs (3.6%), government (3.9%) or both (0.3%). Regarding expressed beekeeping training needs, most of the respondent beekeepers (94.8%) aid they need beekeeping training, and only few respondents (4.9%) said they have no need of beekeeping training due currently unfavorable conditions for

apiculture like effects of agrochemical application on honeybees.

Table 10. Frequency of responses on beekeeping training and material support in West and East Gojjam Zones.

Variable	Category	Frequency	%
Have you attended training on apiculture	Yes	105	27.3
	No	277	72.1
Organizations who gave training	NGO	21	5.5
	Government	80	20.8
	Theoretical	52	13.5
Type of trainings	Practical	4	1.0
	Both	41	10.7
	Hive making	16	4.2
Types of practical training	On both	2	.5
	Others	6	1.6
Have you received beekeeping equipment	Yes	32	8.3
	No	336	87.5
	NGO	14	3.6
Who supported you	Government	15	3.9
	Both	1	.3
Do you need beekeeping training	Yes	364	94.8
	No	19	4.9



## 4. Conclusion and Recommendation

Different brands of herbicide and pesticide agro-chemicals were used for various agricultural crops, and these were identified as having negative effects on honeybee colonies directly and indirectly. Some respondent beekeepers use cultural practices on beekeeping to minimize effects of unwise use of agro-chemicals. There are also poor trends of beekeeping technical training and extension service for beekeepers and huge amount of economic losses of beekeepers due to unwise use of agro-chemicals.

Based on findings of this study, the following recommendations are put forward:

1. The obvious negative effects of agro-chemicals are widespread and need concerned action to develop appropriate application modalities that minimize side effects of agrochemicals on honeybees.
2. There should be applying conflict management tools to control associated conflicts of interest between beekeepers and non-beekeeper farmers regarding agro-chemical application.
3. The reported local knowledge on plant species with toxic effects on honeybees deserves further research.

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