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Demonstration of Bee Technologies at Ana Sora District, Guji Zone, Southern Oromia, Ethiopia

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Abstract: Beekeeping practice is important as ecological conservation and economical source of farmers in agricultural sector. Despite diverse flora in the highlands of Guji zone the beekeepers were not intensively benefited from beekeeping due to lack of modern bee technologies and lack of knowledge and skills of beekeepers on modern beekeeping practices. There are many proven bee technologies. Thus, demonstrating proven bee technologies to beekeepers is important for sustainable honey production. For this study, three kebeles were selected based on their honey production potential. At each kebele 15 beekeepers were selected based on their experience on beekeeping practices. Cast mould, honey extractor, modern hive, queen cage, smoker and etc. were the bee technologies used for demonstration. Method and result demonstrations were intensively used on construction of hive stand, bee transfer, bee management practices and harvesting. Bees were fed by shiro and sugar at dearth period. Trainings and experience of beekeepers were the major extension methods used. Questions were prepared and interviewed to beekeepers before and after demonstration to understand the improvement of knowledge and skills of beekeepers on bee technologies. Descriptive statistics, t test, cost benefit analysis and narration were used to analysis the data. The result of t test showed that there was statistical significance difference between knowledge and skills of beekeepers before and after demonstration. This indicated that this demonstration improved the knowledge and skills of beekeepers' on honey production. On average 27kg/hive of white honey was obtained from demonstration. The result of cost benefit analysis revealed that demonstration of bee technologies generated a return of 3,220 birr/hive/season for beekeepers. This showed that beekeeping is a profitable business at the study area. Improved bee technologies should be disseminated at potential areas of honey production. Beekeepers should use bee technologies for maximum honey production and income generation.

Keywords: Bee, Bee Transfer, Demonstration, Honey, Modern Hive

1. Introduction

Beekeeping, also called apiculture, is management of honey bee colonies for pollination of crops and honey and other products [1]. In Ethiopia, bee keeping practice had been an old age historical practice [2]. In Africa, Ethiopia lead honey and beeswax production and belongs to the top ten worldwide [3]. Ethiopia's tremendous variation of agro-climatic conditions and biodiversity favored the existence of diversified honeybee flora and huge number of honeybee colonies [4]. The country has about 10 million bee colonies and over 800 identified honey source plant [5]. The honey belt zones of Western and Southern parts of Ethiopia produce the largest quantity of honey. There are abundant apicultural resources, particularly in the South Western and South Eastern zones of the country [6]. However, the potentiality of Guji zone in quantity and quality of white honey is not well documented and categorized under honey belt zones of the country. The zone is gigantic potential for honey production.

The honey bee colony consists of three casts (Queen, Worker and Drone). The queen and workers are females and developed from fertilized female eggs and drones are male and developed from unfertilized male eggs. Queen is used to lay eggs. Another function of queen is controlling of the colony activity. For this, a queen has several glands to

produce a complex of compounds called the queen substance. The relationship that exists between a queen and her colony is so close that, the success or failure during honey production depends upon the leadership quality of the queen. Workers are females which are not fully developed sexually. They do the work of the colony and maintain it in good condition. Drones are males of the colony and are produced from unfertilized eggs. Drones do not have any of the structures necessary to collect nectar and pollen. The sole function of the drones is to mate and fertilize the queen. The mating takes place in the air away from the colony [7].

Honey is the most important primary product of beekeeping. The bees collect from the nectar of plants (mainly composed of complex mixture of carbohydrates) by reducing the water content, store and leave it in honeycombs or honey pots to ripen and mature for their own consumption [8-9].

Beekeeping activity has important contribution economically and ecologically. It has remarkable potential to contribute to employment generation, local and global market, livelihood improvement, and biodiversity conservation and helps ensuring economic advantages of women, youths and poor households [6, 10-12]. Development of the Beekeeping practices could significantly enhance crop production, food security, maintenance of plant diversity and ecosystem stability [13].

Despite Ethiopia's great potential for beekeeping the beekeepers were not well benefited from this sector. This is mainly due to the inadequate demonstration of improved technologies and lack of knowledge and skills of beekeepers on honey production. The government and NGOs have recognized to promote transitional and modern beehives. The promotion of modern hive-systems alone is not sufficient to improve the beekeeping situation of a beekeeper due to lack of access to beekeeping equipment and they often do not know how to use or maintain them, resulting in untapped potential [14].

Other bottlenecks for Ethiopian beekeeping practices include poor honey harvesting, diseases, pests, predators, poisonous plants, agrochemicals and deforestation [6]. Lack of beekeeping knowledge, shortage of skills man power, shortage of bee equipment, poor infrastructure development, shortage of bee forage, type of hives and lack of research extension [15-16] were the major constraints of beekeeping in Ethiopia.

The diverse vegetation found in Guji zone helps for environmental conservation and honey production. Gatame *(Schefflera absyssinica)* flower found in the highland areas of the zone is the most important tree used for the production of white honey. Thus, Guji zone of highland areas are well known by the quality and quantity of honey. Despite good flowers and flora species in the area beekeepers of Guji zone were not improved their honey production. They usually used local hives and traditional management practices. Consequently, beekeepers of highlands were not lion share of honey production. Therefore, this demonstration of bee technologies was initiated to improve honey yield beekeepers.

Objectives

1. To evaluate yield performance of modern hive system.
2. To evaluate profitability of modern hive system on honey production.
3. To improve knowledge and skills of beekeepers on bee technologies.

2. Research Methodology

2.1. Description of the Study Area

The study was conducted at Ana Sora district, at Bube Korsa Apiary Site. The area is surrounded by Sama Hindhale, Sololo Kobo and Bube Korsa kebeles. The site is well known by crop production (maize, wheat, barley, potato, enset) and rearing of livestock (mainly cattle, horse, and beekeeping). In addition to flowers of forages and crops the site is also covered by natural vegetation such as Gatame *(Schefflera abyssinica),* Ebicha *(Vernonia amygdalina),* Mokonisa *(Croton macrostachys*, Badesa *(Syzgium guinune)*, Reji (*Vernonia auriculifera*), Wadesa (*Cordia africana*), Tibiro (*Darbergia lacteal*) etc were used for honey bee production during different honey bee harvesting. Gatame tree's flower is important for white honey production while the flowers of Ebicha, Mokonisa and others during *gana* season (Jun-August month) used for black honey that is used for making local beverage called *boka* that is used as traditional drinking during certain ceremonial.

Despite availability of different flowers all most all beekeepers in the study area used traditional hives for honey production. Since there is no source of bee technologies the beekeepers were not using improved bee technologies for better honey production. Even if beekeepers were using traditional hives white honey is still harvested on March and April months. Honey obtained by beekeepers was marketed to different parts of Guji Zone and to regional and national markets (Hawasa and Addis Ababa). So that beekeeping is an important activity that can generates income for beekeepers in the study area.

2.2. Bee Keepers Selection

Kebeles and beekeepers were selected based on their experience on beekeeping. The selections of beekeepers were done with collaboration of Ana Sora Livestock and Fishery Resource Development Office and respective kebele Development Agents (DAs). From each kebele 15 beekeepers (10 men and 5 women) were grouped as one Beekeepers Research Group. Totally, 45 beekeepers were participated on demonstration at initial stages and 36 beekeepers were attended from the initial to the final of demonstration activities. For each kebele 10 modern hives were given for selected beekeepers. On average age of selected beekeepers was 38.86 years which is productive age while their experience in beekeeping was 9 years (Table 1). The selected beekeepers owned mostly traditional hives (17.78) for honey production compared to modern hive (0. 86). This indicated

that beekeepers were using traditional hives than modern and transitional hives for their honey production.

Table 1. *Socio economic characteristics of selected beekeepers.*

Socio economic	N	Minimum	Maximum	Mean	Std. Deviation
Age	36	24	59	38.86	8.047
Experience in bee keeping activity	36	3	18	9.03	3.851
Number of traditional hive owned	36	1	100	17.78	20.692
Number transitional hive owned	36	0	10	1.53	2.197
Number of modern hive owned	36	0	8	0.86	1.710

There many sources of bee in the study area. For female bee keepers freely returned bee was the most source of bee (Table 2). Majority of beekeepers (17) obtained swarm of bees from different sources.

Table 2. *Sources of bee colonies based on sex of beekeepers.*

Sources of bee colonies	Sex		Total
	Female	Male	
Purchasing	-	3	3
Capturing of bee colonies	-	2	2
Taking from relatives	-	2	2
Freely returned bee	5	7	12
Combination of all sources	3	14	17
Total	8	28	36

2.3. Demonstrated Beekeeping Technologies

There are many bee technologies (tools and methods). For this activity different improved bee technologies (tools) were demonstrated during 2019/20 and 2020/21. Honey extractor, cast mould and modern hive were not accessible at the study area though others were obtained with less cost. The following bee technologies were used for the demonstration purpose.

Table 3. *Demonstrated bee technologies.*

N.S	Bee technologies	Main roles of tools
1	Smoker	To smoke that can minimize the fighting of bee/to move bees
2	Honey extractor	To extract and clean honey
3	Queen excluder	To keep the queen in the brood chambers
4	Queen cage	To protect the queen until she adapted the modern hive
5	Ballast	To protect bee from soil or grass
6	Protective clothes	To protect from bee sting
7	Frame	To carry foundation sheet
8	Cast mould	To prepare foundation sheet
9	Beeswax	To make honey injera/foundation sheet
10	Bee brush	To brush bee from mats to modern hive at transferring and to brush bee from honey at harvesting time
11	Hand torch	To give light during transferring bee and harvesting of honey
12	Hive stand	To carry modern hives
13	Modern hive	To produce pure honey and to increase production and productivity of honey
14	Knife	To cut combs from traditional hives and to harvest honey

2.4. Demonstration Processes

This activity primarily depends on showing of improved bee technologies to the beekeepers. There are two types of demonstrations: method and result demonstration. Both demonstrations were used for this activity. Method demonstration is step by step demonstration of improved agricultural research technologies to the end users while result demonstration is mainly used to show the end result of activity at the closing stages of research activity. During this activity method demonstration was used to capacitate beekeepers on improved bee technologies from the beginning to the end of research activity. It is used to show all process of site cleaning, construction of hive stand, bee transfer and bee management practices. Result demonstration focused on harvesting of honey, honey storage and handling of hives after harvesting of honey.

2.4.1. Wax Processing

Beeswax is secreted in small wax platelets form by worker honeybees from four pairs of wax glands on the underside of the abdomens which are functional when the bees are about 9–17 days old after being engorged with honey and resting suspended for 24 hours together [17]. Ethiopia is known for the production of beeswax. More beeswax is obtained from traditional hive than modern hives. Most rural bee keepers in the study area did not know the importance of beeswax though they mostly used traditional hives. Once they harvest their honey they overthrew the beeswax on the field. This is due to lack of knowledge and skills on beeswax that can be re

used for frame attachment for modern hive and foundation sheet. In addition, it was used as a decoration since it can be fashioned by different shape. Moreover, it is used as light in place of worship and rural areas.

For optimum usage of beeswax it should be processed based on the following steps: The first step is cleaning. Beeswax should be cleaned by pure water again and again in container. Secondly, after cleaned, it should be freeze for 12 hours. Thirdly, melting is needed to liquefy the freeze beeswax by heating. This step should be repeated as many times to get pure beeswax. Fourthly, after heating, it should be filtered by cloth/sack. The droplet from the filter will be stored on the bucket while the dust will remain on the filter materials. The fifth step is cooling in the bucket and it should be placed a right position without moving from place to place. This is important to have a good shape of beeswax. Movement of bucket can bend the shape of beeswax. The cooled beeswax should be dried and stored for different usages. In case for attachment of frame the stored beeswax should be re melt. These steps were shown to beekeepers in order to preserve their beeswax from traditional hives. For the purpose of demonstration 30kg of pure wax was purchased. It was melt and foundation sheet was prepared from it. Ten frames of each 30 modern hives were attached by the processed beeswax.

2.4.2. Apiary Site Management Practices

Hive stand was constructed from locally available trees. It ups 60cm above the ground and 40cm below the earth surface. This hive stand was showed to beekeepers to minimize the effect of rainfall drop to the hives as well as minimizing entrance of insects. The hive stands were lubricated by burned oil to protect entering of ant to the hives.

2.4.3. Bee Transferring

Bee can be transferred to modern hives through different options. One option is putting modern hive on its placement. Bee colonies can enter to the modern hive provided that the environment is good for the bees. The other method of transferring of bee is finding the queen. Once the queen is obtained she should be put in the modern hive. In this case beekeepers should care for the queen since she may die during handling. For this demonstration 30 bee colonies were transferred by cutting all the combs of traditional hives and kept on the ballast and moving the bees from ballast to modern hive. The following steps were considered for bee transferring from traditional to modern hive.

1. Cleaning of apiary site.
2. Cable/wire the frame.
3. Dressing protective clothes.
4. Place the mat on the floor.
5. Putting traditional and modern hives on the mat.
6. Preparing smoking materials and smoking to traditional hive by smoker.
7. Cutting all the combs and moving bee colonies from the traditional hive by knife and brush respectively.
8. Put three brood combs on the three frames of modern hive for bees feed.
9. Move bees in to the modern hive and put the modern hive on the constructed hive stand. Traditional hives must be away from apiary site because bees may be returned to it from modern hive.

2.4.4. Feeding Bee During Dearth Period

During no flowering of crops and trees bees were fed by *shiro* (a powder of field pea which has a good smell that can attract bees). 25kg of shiro was purchased and fed bees during dearth period. 15kg of sugar was purchased. Sugar was dissolved in water and given for bees. During the day the feeding material was put beside of hives and during the night and rainy times the materials were taken away from the field and kept under shade where there is no wetness. This was important to protect the bad odor when materials spoiled with moisture. *Shiro* and dissolved sugar feedings were showed to beekeepers during the demonstration. Though not demonstrated to beekeepers giving honey is also another method of feeding the bees during unavailability of flowers in beekeeping activity.

2.4.5. Adding and Removing Super Hives

Adding super is one of bee management in modern beekeeping practice. The importance of adding super is to expand the volume of hive for growing of bee population, to increase honey yield and to prevent swarming. When bees over crowded in the base hive they might panic and flight from the hive. Therefore, to stay bees in the modern hive it is necessary to add another hive where bees are freely moved to prepare quality honey. Beekeepers should also know the time of adding super needed by observing their apiary site. This can be known when bees were observed on external parts of the hive and when the whole combs were covered by bees during active period. Adding super is also known by opening the hive and when beeswax was secreted and observed on frames or on the top bar. Nature of bee (activeness) can also determine adding and removing the super. If the bees were weak it is not necessary to add super. In adding supper, the arrangement of lower (base) and the upper frames should be taken to consideration. The empty frame of the second super frame is placed on the top of the first super frame of full of honey frame. Super hive was removed after honey was harvested and during weak period.

2.4.6. Replacing the Absconded Bee Colonies

Absconding is a great problem in beekeeping activity. During this demonstration 19 transferred bee colonies were absconded from the modern hive. Therefore, it was necessary to replace the lost bee. As to indigenous knowledge to local beekeepers the lost bee will come back to their own hive when the hive is cleaned and smoked by excellent aroma trees. Considering this indigenous knowledge each modern hive was smoked with *anonu* tree which has very important aroma for bees. Four bee colonies were returned after the modern hive was smoked by *anonu*. 10 bee colonies were re purchased and transferred from

traditional to modern hives. Totally, 14 bee colonies were replaced after absconding.

2.5. Extension Methods Used for Demonstration

Appropriate extension methods are important in technology demonstration that can increase adoption of demonstrated technologies in the community. Applicability, complexity and usage of technologies should be clearly stated by extension methods that can foster technology adoption. Therefore, on spot trainings, field day and experience sharing among beekeepers were the major extension methods intensively used for bee technologies promotion in the area.

2.6. Methods of Data Collection and Analysis

Observation was used to collect data at apiary site. Some questions were prepared and interviewed to beekeepers before and after demonstration in order to understand the improvement of knowledge and skills of beekeepers on bee technologies used for honey production. Before and after analysis (paired t test), descriptive statistics, cost benefit analysis and narration were used to analysis the data.

3. Results and Discussions

3.1. Capacity Building Methods on Bee Technologies

Most agricultural sector needs land for production. However, beekeeping did not necessarily need much of land. It can be started by landless youth, female, male or associations provided that beekeepers were capacitated to produce the honey. This indicated that beekeeping practice is a business entry point for resource poor communities because most activities were done by bees. The most important for beekeepers is information (knowledge and skills) and materials (bee technology accessories) used for honey production. The main goal of agricultural research extension (technology transfer) is capacity building on the recommended technologies. The aim of agricultural extension is to enhance farmers' knowledge and skills on the recommended agricultural technologies [18]. Many proven bee technologies were left on shelf due to lack of beekeepers capacity to implement on their field. When technology users capacitated the technology transfer from research recommendation to technology user is simple so that agricultural extension system should focus on capacity building.

During demonstration of bee technologies knowledge and skills of beekeepers were capacitated by on spot trainings, farm visit and field day. Three times trainings were given for 45 selected beekeepers at different stages of demonstration (during construction of hive stand stage, bee transferring stage and bee harvesting stage). Demonstration site was monthly visited and monitored by researchers. During monitoring, the demonstration site comments and suggestion were given for beekeepers. Field day was organized in order to enhance bee technologies to large communities (Table 4). Despite small land is required the bee technologies, for instance, honey extractor, cast mould, modern hive and even protective clothes were not accessible and expensive for beekeepers at study area. For this demonstration 30 modern hives were obtained from Jimma Agricultural Engineering Research Center while other accessories were taken from Bee Research Team of Bore Agricultural Research Center.

Table 4. *Capacity building on bee technologies demonstration.*

Trainings topics	Beekeepers		Subject matter specialists		Development Agents	
	Male	Female	Male	Female	Male	Female
Hive stand construction and bee transferring	31	14	5	-	5	-
Seasonal management	30	15	3	-	4	1
Honey harvesting and management	30	15	4	-	4	2
Field day	96	19	24	7	17	4
Total	187	63	36	7	30	7

3.2. Knowledge and Skills Improvement on Demonstrated Bee Technologies

Agricultural productions not only need the labor but also need knowledge and skills to implement. The main intention of agricultural extension is to enhance the knowledge and skills of farmers on recommended agricultural technologies [19-21]. Beekeeping, whether it is result or method demonstration, needs knowledge and skills on honey bee production. Availability of materials alone did not a guarantee for honey production unless utilizing the knowledge and skills recommended for technologies. Improvement of knowledge and skills of demonstration is required for sustainability of activity by end users. Thus, information delivered during trainings, follow up and monitoring were used to remind the knowledge and skills transferred for the selected beekeepers. Knowledge and skills demanded questions were prepared and interviewed to the selected beekeepers before demonstration (Appendix). The same questions were re interviewed to the beekeepers at the end of demonstration. The result of paired sample t test showed that there was statistical significance difference (0.001 was less than 0.05) between knowledge and skills before and after demonstration of beekeepers on bee technologies at the study area. This indicated that this demonstration improved knowledge and skills of beekeepers' on honey production.

Table 5. *Knowledge and skills test result.*

Test	Mean	N	Std. Dev	T	Df	Sig. (2-tailed)
Knowledge and skills after demonstration	72.38	36	8.73	-	-	-
Knowledge and skills before demonstration	50.58	36	16.03	-	-	-
Knowledge and skills after demonstration - Knowledge and skills before demonstration	21.80	36	17.30	7.60	35	.001

3.3. Yield and Cost Benefit Analysis

At the study area two types of honey can be harvested (April month the white honey and August month the black honey). For this demonstration, only white honey was harvested while black honey which is mostly used for local consumption was not harvested and left for bees as the feed. Honey also harvested from the super added (two supers) hives and not from the base hive. For the analysis purpose only honey obtained from the super was considered. Honey was harvested from each 10 frames of modern hive. On average 27 kg/hive of white honey was obtained from this demonstration. The result of this demonstration was above the results of [22-23] who reported that the average honey yield of transitional and modern hives ranges from 15 to 20 kg and less than the maximum of 47kg/hive in Europe where modern hive systems are dominant [3].

Table 6. *Yield and cost benefit analysis.*

Parameters	Value in ETB
Honey harvested per hive in kg (q)	27
Farm gate price (p)	250
*A. Total revenue (TR= q*p)*	6750
Cost of modern hive	2,500
Depreciation of modern hive (a)	2250
Cost of bees purchased (b)	500
Beeswax in kg (c)	300
Costs paid for hive stand construction (d)	180
Bee feeding costs (e)	300
B. Total costs (TC= a+b+c+d+e)	3,530
Benefit gained (A-B)	3,220

Cost benefit analysis was used to estimate the profitability of bee technology demonstration on honey production. Only white honey harvested from the added super was used for profitability analysis. If the black honey which was left for bee feed was considered the harvested honey and profitability gained from this demonstration would be greater than this result. The farm gate price of 1kg of honey at the time of harvest was 250 birr. Total Revenue (honey harvested multiplied by the price) was 6750 birr/hive. Many costs were used to estimate the costs of honey production. One modern hive can serve 10 years. At the study area, the cost of modern hive during demonstration was 2,500 birr. Strong bee colonies were purchased from surrounding apiary site. One traditional bee hive colony was purchased by 500 birr. 1kg of pure beeswax was purchased by 300 birr. Hive stand was constructed from locally available trees which were estimated to 180 birr. To feed bees during dearth period sugar and *shiro* was purchased for 300 birr. The result of cost benefit analysis revealed that demonstration of bee technologies generated a return of 3,220 birr/hive/season for beekeepers (Table 6). Generally, this demonstration indicated that use of bee technologies generated high income for beekeepers.

3.4. Beekeepers Opinion on Beekeeping Practice

Since beekeeping is important for income generation and honey consumption beekeepers provide their opinion regarding the current status of beekeeping in their area. Bees need flowers (trees, vegetables, crops, shrubs, etc.) for honey production. This indicated that beekeeping is interlinked with crop production activities. Due to the bees' nature, many ecosystems depend on the pollination of bees for their existence and for increasing their genetic diversity (cross-pollination). A decline in bee colonies and bee species could therefore threaten the survival of plant species that depend on the pollination services of bees [24]. In order to increase the production and productivity of crop production that can feed the growing human population the current agricultural extension system in the country in general and at Ana Sora district in particular recommended full packages of chemicals (herbicides and fungicides) to control weed, rusts and insects. Beekeepers explained that the amount of bee colonies available in their area was decreased from season to season due to application of chemicals that kills bees at the time of collecting nectars from plants. Diseases also affected the bees. However, bee colonies become source of income as some beekeepers were selling their bee colonies from traditional hives.

Absconding of bees was the critical problem of beekeepers at study area. Though beekeepers used indigenous knowledge in replacing absconded bees the main reason of absconding was not known. Despite the area was potential for honey production the beekeepers mentioned that there were no suppliers of bee technologies in their district.

4. Conclusions and Recommendations

Highland Guji zone is a potential for white honey production. However, due to lack of improved bee technologies and lack of management practices the beekeepers were not much benefited from beekeeping practices. Therefore, demonstrating improved bee technologies is needed for sustainable honey production. Different bee technologies (modern hive, cast mould, honey extractor, etc.) were demonstrated. Different trainings were given for beekeepers so that there was improvement on knowledge and skills of beekeepers after demonstration of bee technologies. In addition, 27kg/hive of honey was obtained from the demonstration. Availability of improved bee technologies can increase bee keepers' honey production. Use of improved bee technologies and good conditions can

increase honey production at highlands of Guji zone. The result of cost benefit analysis revealed that demonstration of bee technologies generated a return of 3,220 birr/hive/season. This showed that beekeeping at Ana Sora district was a profitable business for beekeepers. Despite good honey harvested and profitable the beekeepers of study area generally face different challenges such as decline of bee colonies, diseases, chemicals, deforestation of trees, absconding and lack of bee technology suppliers were the major challenges of beekeepers at the study area.

Demonstration of bee technologies increased the yield of honey that can maximize income of beekeepers. Therefore, improved bee technologies should be disseminated at potential areas of honey production. Improved bee technologies should be supplied by government as starting point. Beekeepers should use bee technologies for honey production. Farmers should give consideration when using chemicals that can affect the bees. Apiculture sector should find solutions for absconding and diseases of bee at the study area.

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Appendix: Questionnaire Prepared for Knowledge and Skills Improvement on Bee Technologies Demonstration

Name of beekeeper _____District _____ Kebele _____
Sex _____ Age_____ Beekeeping practice _____years
Answer the following questions

1. Mention types and number of hives owned

N.S	Mention types of hive owned	Number of hives owned
1		
2		
3		

2. Sources of bee colonies

N.S	What is/are the source of bee colony for your beekeeping?
A	Purchasing
B	Capturing of bee colonies
C	Taking from neighbored beekeepers
D	Splitting
E	Bee colonies freely returned to their original hive

3. Mention 10 materials used for bee transferring (10%)
4. When did transferring of bee conducted in your area? (month) (2%)
5. Tell the method of transferring bee (4%)
6. What steps are used to transfer bee from traditional hive to modern hive? (15%)
7. Mention three feeding materials used during off season/dearth period (3%)
8. Explain seasonal management needed for apiary site (10)
9. Can you transfer bee from traditional to modern hive 4% (Yes =4, No =0)
10. How many days bees oriented to the environment before transferred to modern hive? (1%)
11. What are cautions needed in bee transferring? (6)
12. Can you show transferring of bee to your neighbor bee keepers? 5% (Yes =5, No =0)
13. What is the height of hive stand from the ground? (0.5%)
14. What are the three importance of wax? (3%)
15. Mention the steps of bee wax processing (5%)
16. Why adding super is important? (4%)
17. When adding super is done? (3%)
18. How one can add super (arrangement of frame)? (4%)

19. Explain the role of the following bee technologies 11% (each had one 1%)

N.S	Bee technologies	Roles (11%)
A	Smoker	
B	Honey extractor	
C	Queen excluder	
D	Queen cage	
E	Ballast	
F	Protective clothes	
G	Frame	
H	Cast mould	
I	Beeswax	
J	Bee brush	
K	Modern hive	

20. Mention four materials used for harvesting of honey 2%
21. When harvesting of honey is conducted? (month) (1%)
22. Tell me types of honey obtained during different seasons in your area (2%)
23. Cautions needed during harvesting of honey (2%)
24. Explain the post-harvest managements of honey (2.5%).

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