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Demonstration and participatory evaluation of apiculture technologies in Sidama National Regional state, Ethiopia

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Abstract

Demonstration and Participatory evaluations of improved beekeeping technologies were conducted in Loka Abaya and Hawassa Zuriya woredas of Sidama National Regional state with the objective of demonstrating improved beekeeping technologies & strengthen research extension farmer's linkage in beekeeping technology generation and transfer. Demonstration and evaluations of frame and transitional hive was conducted by forming farmers research groups (FRGs) at 4 peasant association (PAs) of selected district; from the demonstration an average of 25.5 kg semi-extracted and 10.5 kg crude honey per hive/annum was harvested using after and before using improved technologies respectively and bees wax purification was also demonstrated on farmers field. Partial budget analyses implied that adoption of improved beekeeping technologies make small holder beekeepers more profitable than traditional practice. Therefore, all the demonstrated and evaluated technologies have been recommended for the mandate area to further promote the technologies in to the areas where there is a gap in utilizing and disseminating the technologies.

Keywords: Demonstration, improved beekeeping, profitable

1. Introduction

1.1 Background of the study

Beekeeping is an important agricultural and traditionally well-established household activity in almost all parts of Ethiopia. Owing to its varied ecological and climatic conditions, the country is home to some of the most diverse flora and fauna in Africa, making it highly suitable for sustaining a large number of bee colonies. The country has about 10 million bee colonies and over 800 identified honey source plant (Gebremichae *et al*, 2018; Addisu *et al*, 2018) [1, 6]. It is a suitable farming activity known for its valuable products (honey, beeswax, pollen, royal jelly, bee venom and propolis) used in foods, cosmetics, medicines, and engineering industries as well as pollination services (Espolov *et al*., 2014; Gemechis, 2014; Gezahegn, 2016; Samuel, 2017) [5, 7, 9].

Sidama region is a very long-standing practice in the Beekeeping farming activities and it plays a significant role as source of additional cash income and nutrition for many subsistence farmers. In the region, the apicultural resources are immense and the natural vegetation coverage is relatively high, as a result in this area the honeybee population is dense and production is relatively high. Besides, the beekeeping potentiality the region is partly attributed to the various cultivated cash crop (Coffee and Chat), Pulse, Enest, Horticultural crops and different herbs, which are very important for source of forage (Sebsib and Yibrah, 2018) [10].

Most of the beekeeping practice in the area is dominated by backyard beekeeping using traditional beehives. There are about 36, 616 bee colonies in the region, of which about a total of 35,409 (96.7%), are managed in traditional beehives (CSA, 2019) [3]. Traditional hives are the mainstay of honey production until recently, but they are backward, time consuming to construct and give low yields compared to the improved way of production (Alemayehu *et al*. 2016) [2]. The productivity of traditional hives is extremely low and the average honey yield is only about 5-8 kg/per colony/per annum (MoARD, 2013) [8]. To increase production and productivity of honey bee colonies man can also stimulate honeybee colonies to multiply themselves as well as facilitate living box. Different queen rearing technologies that fit to local condition and honeybee races were developed by Hawassa Agricultural Research Center. Of these technologies, Splitting technique is simple and can be easily practiced by farmers, and 5 to 10 queens can be reared from a colony. The technology is important to increase honey bee colonies and amount of honey yield per year per household. The trend of splitting queen rearing technique around Remeda bee research station was effective and participant farmers benefited from sell of colonies and honey. Thus, this finding led us to verify and demonstrate the reliability of splitting queen rearing technique with regard to honeybee colony multiplication in improved hives under farmer's condition. In 2019/20, ORTDP was plans to supported food insecure households in the study areas. Most of the intervention woredas had no access to these technologies due to financial limitation. In order to increase the productivity of honeybee and to expand improved beekeeping technologies in a community, the project was plans to popularized and scaled up improved beekeeping technologies as well as practical improved bee management

training. Therefore, this activity was designed to demonstrate and evaluate the improved beekeeping technologies to farmers in potential honey producing areas in Loka Abaya and Hawasssa zuriya woredas, sidama national regional state.

2. Material and Methods

2.1 Site and farmers' selection

The activity was carried out for four years (2016/17-2020/21) in two Districts (Loka Abaya and Hawassa Zuriya) of Sidama regional state with purposively selected based on the ORTDP targets. There were 80 and 70 participating food insecure household's beekeepers in Loka Abaya and Hawassa zuriya, respectively based on their interest towards the technologies, willingness to manage the research activity. About 130 and 20 of the beneficiaries were male and female farmers respectively. Around 48 of them district agricultural office experts and development Agents (DA) had taken part in training.

2.2 Research Design and sampling technique

In each Kebeles, one FRG containing 10 members in to two demonstration sites (apiary of voluntary beekeepers) in which case a total of 4 FRGs were established containing 6 demonstration sites. Demonstration was carried out on Frame and transitional hives, queen rearing and colony multiplication, protective cloth and bee management (colony transfer, dearth period colony management, swarm control, hive inspection, and replacement of old and damaged combs), improved bee forage planting and purifications of crude bees wax in to pure beeswax. Multi-stage sampling procedure was used to select sample smallholder beekeepers for the interview. In the selected kebeles, the beekeepers were stratified into ORTDP beneficiary and non ORTDP beneficiary of improved beekeeping technologies. Having the list of beekeepers from each kebeles, 250 sample beekeepers (150 ORTD beneficiary and 100 non beneficiary) were selected randomly based on the probability proportional to size sampling technique from the selected kebeles.

2.3 Data analysis

The collected data (quantitative data) were analyzed by using descriptive statistics such as average and frequency distribution while qualitative data were analyzed using preference ranking.

3. Results and Discussion

3.1 Training of farmers and other stakeholders

From the total of 198 participants, about 150 of them were direct ORTDP beneficiaries (beekeepers) and 48 of them were district agricultural office experts. Training was organized and given for experimental farmers, development agent (DAs) and beekeeping expertise. The contents of the training were on the advantages, disadvantages traditional, transitional and improved bee hives, honey bee diseases and enemy control, colony transferring, dearth period colony management, hive inspection, honey harvesting, wax purification, foundation sheet making and colony multiplication at each Kebeles of FTC for three days. Finally, colony transferring was made with the farmers following delivering of frame and transitional hive with other required inputs. The following table illustrates the number of farmers and experts participated on the training.

Table 1: Total number of participant in the training at each woredas

Woredas	Year	Participants					
		Farmers			Experts		
		Male	Female	Total	Male	Female	Total
Loka Abaya	2016/17	20	0	20	4	1	5
	2017/18	13	2	15	3	2	5
	2018/19	12	3	15	4	1	5
	2019/20	18	2	20	4	2	6
	2020/21	10	0	10	4	0	4
Hawassa Zuriya	2016/17	12	3	15	3	1	4
	2017/18	13	2	15	3	2	5
	2018/19	17	3	20	4	0	4
	2019/20	8	2	10	3	1	4
	2020/21	7	3	10	4	2	6
Sub Total		130	20	150	36	12	48
Total	198						

Fig 1: Farmers training on foundation sheet making, colony transferring and crud wax processing

3.2 Provision of improved bee hives, transferring of colony and queen rearing

One of the goals of the project was to discuss with the community and possibly demonstrate improved beehive. The table shows that, total number of beehives offered to the farmers from 2016/17 to 2020/21. In 2016/17, there were no improved beehives belongs to the ORTDP beneficiaries in the study area while it increasing to 300 improved beehives since 2020/21.

Colony transfer is preferably undertaken during honey flow period by the beekeepers in the area. Bee colonies were transferred from traditional hives to the improved hives. Out of the provided 300 improved hives around 286 of them made honey bee colonies transferring. In order to transfer the colony by using smoke they used to drive the bees from the traditional hive to the improved one, followed by the evacuation of bees from the traditional hive. During transferring, supplemental feeds, honey and bee broods were transferred from the traditional beehive to the transitional and modern beehives. Around 95.5% of bee colonies were transferred and accepted to frame & transitional hive in the area. All managements were done after transferring to transitional and modern beehives to maintain similar strength of the colony

In addition to the existing colony, beekeepers were practice queen rearing by splitting technique for increasing of bee colonies in their apiary. After the training, beekeeper involves the splitting of strong colony into two or more divisions in their apiary. They can get around 89 additional colonies by splitting queen rearing technique in the area. It's have a role to the ecology and increase honey yield in the area. This means that pollination needs to be considered within the physical, environmental, and biotic context in which it takes place, which has led to the rise of the field of pollination ecology and honey yield in the area.

Table 2: Amount of improved hive distribution to ORTDP beneficiaries in different season.

Districts	Year	Type of Hive	NPH	NBCT	NSC
Loka Abaya	2016/17	Frame Hive	20	16	0
		Transitional	20	20	0
	2017/18	Frame Hive	15	15	5
		Transitional	15	15	4
	2018/19	Frame Hive	15	15	6
		Transitional	15	15	4
	2019/20	Frame Hive	20	15	6
		Transitional	20	20	8
	2020/21	Frame Hive	10	10	4
		Transitional	10	10	5
Hawassa Zuriya	2016/17	Frame Hive	15	15	2
		Transitional	15	15	0
	2017/18	Frame Hive	15	13	4
		Transitional	15	15	7
	2018/19	Frame Hive	20	20	9
		Transitional	20	17	6
	2019/20	Frame Hive	10	10	6
		Transitional	10	10	4
	2020/21	Frame Hive	10	10	4
		Transitional	10	10	5
Sub total			300	286	89

NPH=Number of provided hive, NBCT Number of bee colonies transferred from traditional to improved hive and NSC= Number of split colony (queen rearing and colony multiplication)

3.3 Trends of Honey production

The trend of honey production during the period from 2016/17 – 2020/21 has been increased. The beneficiaries assumed that increased trend of honey bee products in the area. This is due to be getting of additional colonies by queen rearing training and adoption of improved beekeeping technologies in area. In all demonstration sites, the honeybees accepted the frame and transitional hive. The comparison of honey yield of improved hive with traditional hive was also done at each demonstration sites. Accordingly, the average yield obtained per annual from improved and traditional hive was increase throughout the production year. Current findings are in harmony with Amina Saied, 2019 [3], there has been an increasing trend of using modern technologies particularly top bar and commercial hives. For instance, results suggest that, number of adopters of commercial hives have increase from 5% to 10% whereas top bar hives adopters have increased from 13% to 17% in 2017 and 2018 respectively. From this we can conclude that honeybee products production was an increasing trend due to introduction of perennial bee forage plants, introduction of different beekeeping tools like frame and transitional hive, increase awareness of improved beekeeping in the area.

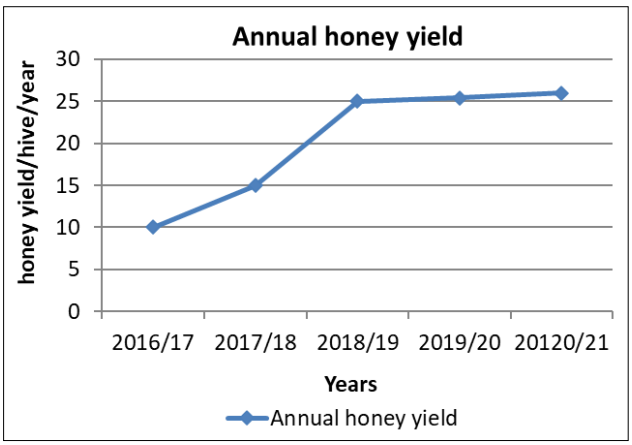

Fig 1: Trends of honey production in different production season.

3.4 Honey bee flora plantation practices

Five newly introduced honeybee forage seeds (*Bacium grandflorum*, *Sweet clover*, *R. Linores*, *O. Fruticos (Bicha Abeba)*, *Fagofilla fobbing*) distributed to the beneficiaries. These forages were planted in front of beehive on the farm land of participating farmers to be used as supplementary feed in order to strengthen honeybees' colonies and increase honey production. Before the training, the sample households do not plant honeybee flora due to lack of awareness and honey bee flora seedling. The natural bee forage is seasonal and, hence, feed shortage occurs in some months of the year, especially from January to June.

Fig 2: Pictures of distributed and planted improved bee forage plant

3.5 Field day and visit

Field visit to Danshey Gambela kebele in April 2020 was arranged at one apiary of beekeeping farmers with the main objectives of observing apiary site management, effectiveness of different technologies and demonstrating crude bees wax purification methods to farmers. The participants were experimental farmers, non-experimental farmers, DAs and expertise. After the field visit, participants met for reflections of observations on the field visit, overall training process and future project plan. In the round up session, development of action plan, sharing of responsibilities and resource mobilization for the intended activities. Woreda administrators expressed their appreciation for the project and the training program. They also said that they will take responsibility of mobilizing the community and further committed themself to take up the project's issue to the Woreda political bureau (cabinet) level so that the plan becomes part of the Woreda's own plan.

3.6 Farmers perception of improved beekeeping technology

An analysis of farmers' knowledge, particularly their perceptions and attitudes regarding the benefits and constraints of using improved beekeeping technologies as compared to traditional one is essential for explaining why farmers prefer/not prefer the technology. Table3 shows farmers' perception for benefits that could be obtained from improved honey production as compared to the traditional one. In their observation, the benefits of improved box hive fall into mainly durability of the hive, ease of inspection and management of the hive, swarm control, labor-saving, quality and quantity of honey. Of these benefit characteristics, quantity of honey produced and quality of honey (marketability of hive products), swarm control, durability of the hive, ease of inspection and management were remarked by 11.5, 10, 14, 11, 8.5 and 6% of the farmers, respectively. For instance, farmers' perception for the quantity of honey produced from improved box hive can also be confirmed with the quantitative results. This implies that honey produced from improved box hive (25.5 kg per annual) after the technology used. It was significantly higher than the honey produced from traditional beehive (10 kg per annual per beekeepers) in the study area. On the other hand, even though, the average price of honey produced from improved box hive (100 ETB) was higher than that of the average price of honey produced from traditional beehive (200 ETB). Furthermore, not only the farmers observed the comparison of benefits between improved and traditional beehives but particularly farmers also observed the comparison of benefits of using improved box hive and they were ranked as 1st, 2nd, 3rd, 4th, 5th, 6th, for Quantity& quality of honey, ease of inspection and management, hive durability, swarm control, used for queen rearing and labor saving.

Farmers reported various constraints that hinder to using of improved beekeeping technologies. The main constraints that limits improved beekeeping technologies ORTDP beneficiaries were suggested by the farmers as price of improved inputs, need accessories, need high skill and susceptibility to pests, predators and diseases and absconding due to different natural and man-made factors. According to the respondents' perceptions, disadvantage of using improved beekeeping technologies also ranked depending on the level of seriousness as 1 st, 2 nd, 3 rd, 4 th and 5 th, for improved inputs, need accessories, need high skill and susceptibility to pests, predators and diseases and absconding respectively (Table 3).

Table 3: Perceptions of farmers regarding the benefits of using improved beekeeping technologies and its constraint compared to traditional beehive and their prioritization

Advantage of using beekeeping technologies	ORTDP Beneficiaries (N=150)	Non-Beneficiaries (N=100)	Combined (N=200)	Rank
Management and inspection	20 (13.33%)	3(3%)	23(11.5%)	2nd
Swarm control	15(10%)	5(5%)	20(10%)	4th
Quantity& quality of honey	25(16.67%)	3(3%)	28(14%)	1st
Durability of hive	18 (12%)	4(3%)	22(11%)	3rd
used for queen rearing	12(8%)	3(3%)	17(8.5%)	5th
Labor-saving	10(6.67)	2(2%)	12(6%)	6th
Disadvantage of using technology				
Needs high skill	15(10%)	7(7%)	23(11.5%)	3rd
Needs accessories	30(20%)	5(5%)	35(17.5%)	2st
Absconding of bees	5(3.3%)	2(2%)	7(3.5%)	5th
Susceptibility to pest and diseases	15(10%)	3(3%)	18(9%)	4th
High cost	35(23.3%)	2(2%)	37(18.5%)	1st

***Source*:** Survey output (2018); N, number of observations; %, percentage of observations

3.7 Partial budgeting result

Partial budget method was used to evaluate the changes from one technology to another by comparing the changes in costs and benefits associated with each practice. In this case, for the profitability analysis, comparison of the net benefits from traditional beehive and improved box hive was made in per hive basis. This analysis excludes the fixed costs such as land, bee colony, shade, labor and honey harvesting. Moreover, in this case, both hives were assumed to be used for production rather than for multiplication of bee colony. All benefits and costs should be calculated using the nearest market prices and input costs. Input requirements and their costs that vary for both improved and traditional hives were shown in Table 6. The partial budget for improved and traditional honey production practices. The result shows that traditional beehive yield on average 10 kg/hive/year at its average price of 100 ETB/kg while improved box hive yield on average 25.5 kg/hive/year at its average selling price of 200 ETB. Hence, average yield and average price of improved box hive is higher than traditional hive. Significant amount of money can be earned from selling of pure honey produced per improved hive than from traditional hive. This indicated that 11500 ETB from improved hive and 4650 ETB from Zander hive afford net income per beekeeper from 5 hives. The study clearly showed that improved beekeeping technologies were the better income generation per beekeeper from selling of honey.

Table 4: Average input requirements and costs of both practices.

Major items	Unit price (ETB)	Service year of items	Items per beekeeper	Improved hive	Traditional hive
Casting mold	5000	10	1	500	-
Honey extractor	5000	10	1	500	-
Beeswax cost	300	-	5	1500	-
zander hive purchasing	3000	10	5	300	
Traditional hive purchasing	50	7	5	-	70
Total production cost				2800	70

Table 5: Yearly cost and return of each beehive types per beekeeper owned 5 bee hives

Beehive type	Total production cost (ETB)	Gross return (ETB)	Net income per beekeeper (ETB)	Net income per hive (ETB
Improved	70	5000	4650	930
Traditional	2800	25500	11500	2300

4. Conclusion and Recommendation

Demonstration and evaluation of improved beekeeping technologies through participatory approach is one means of technology promotion to large numbers of technologies beneficiaries in areas where there is a need to popularize the technologies. According to the smallholder beekeepers perception adoption of improved beekeeping technologies has relatively high benefit over traditional practice in its ease of management and inspection, honey quantity and quality, swarm control and hive durability. Therefore, great effort need to be made by government organization and different development partners in supplying improved beekeeping technologies on the basis of farmers' purchasing power and develop technical skill of beekeepers on beekeeping technologies.

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