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# ENHANCING RURAL FOOD SECURITY AND CONSERVING NATURAL ENVIRONMENT THROUGH IMPROVED BEEKEEPING IN ASANO KOTO WATERSHED, ETHIOPIA

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**Abstract**: The role of bees in agriculture, in maintaining biodiversity and in sustainable livelihoods and food security has been widely demonstrated. Nevertheless, the potential of beekeeping is far too often not exploited in forest activities and development programmes, because the benefits of bees and beekeeping are not well known to stakeholders. This paper is aimed to provide farmers and stakeholders in the beekeeping on the conservation sector with information and arguments to convince them to view beekeeping as aviable commercial and protective measure that should always be considered in conservation programmes. The study revealed that by increasing beekeeping skill, honey producers in the watershed realized the value and the need to conserve watershed as they obtained alternative income from honey production as high value commodity. Adoption of beekeeping was realized to be appropriate adaptation measures following the fact that it improved livelihood of local people and enhanced sustainable conservation of the natural environment. Therefore, if watershed conservation and livelihood preservation are to occur, it is important to bring the voices of honey producers to the forefront of watershed conservation efforts. The study also determined several factors that have been barriers to wider adoption of beekeeping at Asano koto watershed. These include lack of appropriate beekeeping skills among local people, financial constraints and environmental factors. To promote and sustain beekeeping among rural communities at the watershed, improvement of extension services, tree planting campaign and microfinance services have been suggested.

**Keywords:** Food security, watershed conservation, integrated beekeeping, Siltie zone, Ethiopia

**Introduction:** Beekeeping which is a forest and horti-agriculture based industry can play an important role in the development of hilly areas, as it increases economy without changing environmental balance.

As a cottage industry it is an important income generating activity for the rural people of hills Success of beekeeping depends upon some basic factors such as suitable climatic conditions, bee forage, bee management and bee breeding. The

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combinations of these factors lead to better honey and beeswax production.

In Asano koto watershed area, similar to other part of the country, livestock sector, particularly Beekeeping sector play an important role in livelihoods of rural people. Apiculture is one of the important agricultural sector that utilize natural nectar and pollen which otherwise would be wasted and contributed to the income of smallholder farmers (Melaku *et al*., 2008). Apiculture is deeply rooted in the Ethiopian rural life and has a long tradition of beekeeping with about 3-5 million honeybee colonies producing about 21 thousand tones of honey annually (Fitchl and Admasu, 1994).

According to Crane (1990), apiculture is floral based industry and bees wholly depend on plants for their food; and from 250000 plants in the world, about 40000 plant species are important for honey bee as a food source. Bee colony performance as well as production of honey, wax and other hive products depends on bee forage plants from which honey bees obtain nectar and pollen as main food. These food sources provide the nutritional requirements of the bee colonies: nectar as sources of honey provides heat and energy for honey bees and pollen provides protein, vitamins, fatty substance, and other nutrients (Amsalu, 2000). Due to its wide climatic and edaphic variability, Ethiopia is endowed with diverse and unique flowering plants of 6000 to 7000 species thus making it highly suitable for large number of colonies and long practice in beekeeping (Admasu, 1996, Fitchel and Admasu, 1994; Gezhagn, 2007, Gidey and Mekonen, 2010). The diversity of plants species comprises forest trees, bushes, grasses, and cultivated flowering plants that are actually and potentially useful for beekeeping (Teklu G, 2016). For instance, rehabilitation of areas through reclamation and exclosure coupled with soil and water conservation efforts with improving conditions for apiculture (Bedru *et al*., 2006). Therefore, transforming enclosure or watershed in to apiary is just one example of a possible "win win situation" for poverty alleviation (Jocobs *et al*., 2006).

The activities of this research covers the role of bees in nature preservation and describes the value of bees for human economy and nutritional value of beekeeping at household level, and the economic value at community level

**Objective:** This paper outlines how beekeeping can contribute significantly to forest conservation and poverty alleviation. The arguments in the paper are intended to provide farmers and forestry stakeholders (including policy-makers) with the necessary information and motivation to consider beekeeping as a viable commercial and protective activity that should always be considered and integrated in national conservation and poverty reduction strategies.

**Literature Review:** The sense of urgency in Ethiopia today is more than ever about fostering sustainable development, to end poverty and hunger. Ethiopia is an agrarian country where around 95% of the country's agricultural output is produced by smallholder farmers (MoARD 2010). The contribution of agriculture to gross national product(44%), employment(85%), export earnings(90%), and supply of industrial raw materials(70%) has remained high(World Bank 2010). Ethiopia has been experiencing chronic food insecurity. About 29 per cent of the population lives below the national poverty line (IFAD 2012). In reality, the numbers increased due to several shocks that increased food insecurity in rural Ethiopia, such as food price spikes and rain failures (Stephen Devereux, *et al, 2014)*.Hence, the ability of the nation to address food and nutritional insecurity, poverty, and to stimulate and sustain national economic growth and development is highly dependent on the performance of agriculture. From agriculture, livestock contribute up to 20% to Ethiopia's GDP and livelihoods of 60–70% of the population. Beekeeping, which is one of the important livestock subsectors, contributes significantly to the improvement of the

livelihoods of the nation's population (Aklilu, 2002).

Ethiopia has a potential in beekeeping as the climate allows growing of different vegetation and crops which are a good source of nectar and pollen for honeybees. Large and diverse botanical resources combined with suitable climatic conditions make it conducive for the beekeeping business (Nuru *et al*., 2001). Due to this suitable natural environment, large honeybee colonies, which are estimated to be about 10 million, exist in the country (Workeneh, 2007).

According to Ayalew (1978) beekeeping had started in the country between 3500-3000 B.C. Beekeeping extension was initiated in 1965 with the establishment of Holeta Bee Research Center (the then Holeta Beekeeping Demonstration Station) and other similar stations in different parts of the country (Workeneh, 2007). But, formally organized beekeeping extension started in 1978 (Ethiopian Beekeepers Association [EBA], 2005).

Beekeeping is an important component of agriculture and rural development programmed in many countries. The role of beekeeping in providing nutritional, economic and ecological security to rural communities at the household level and as an additional income generating activity is high (FAO, 1990). Beekeeping is a good source of off-farm income to farmers in our country. It plays significant role in supplementing the annual income and has potential to increase incomes of the beekeepers through sell of honey, beeswax, colonies and serving as a healthy food for the consumers. It provides not only direct job opportunities, cash income and food in the rural areas, but also assists the increased agricultural production of various crops through pollination effect of honey bees. As very little space is needed, beekeeping is ideal for people who have no land, little space and money. The net return from a well-managed beekeeping is generally thought to be significantly large.

Traditional production system experiences many challenges that reduce production and productivity of the subsector. Among these, poor management skills, shortage of honeybee forages, disease and pests are the major ones. The annual crude honey yield per traditional beehive is 5-7kg. It is very low in quantity and quality compared to national average of improved box hive, which is and 20-25kg. Many efforts made in generation, modification and dissemination of beekeeping technologies that increase production and productivity and maximize benefit from beekeeping in line with sustainable natural resource conservation. Employing improved beekeeping technologies with its accessory and full packages enable the beekeeper to produce surplus honey (Teklu G., 2016).

**Materials and Methods**

**Characteristics of the study area:** The study was conducted in Asano koto watershed in silti Woreda of siltie Zone in Southern Nations, Nationalities and Peoples Regional State (SNNPRs), Ethiopia. The watershed is sited at 38o 22` E and 8o o7` N about 180 km east of Hawassa the capital city of SNNPRs or 135 km west of Addis Ababa, capital city of Ethiopia, at an altitude range between 1964 and 2200 meter above sea level. Topography is characterized by steep, undulating slopes divided by v-shaped valleys of seasonally intermittent streams and characterized by clay silt in soils texture and with pH value of6.3. The small rainy season (*belg*) extends from middle March to April while the main rainy season (*meher*) extends from June to early October. The month of July and August receive the highest rainfall and cause soil loss. In when this experiment was conducted, the annual rainfall was 1029 mm.

However; there is a marked year to year fluctuation in the pattern of rainfall distribution. The average annual minimum and maximum temperature of the watershed were 14 o and 24o, respectively. The watershed is characterized by food insecurity, land degradation, feed shortage, land shortage and poor soil fertility.

**Respondent's selection:** Participatory Rural Appraisal (PRA) was conducted by a multidisciplinary team of researchers and agricultural development agents. During PRA survey, beekeeping is identified as one of the components that ensure the long-term watershed rehabilitation, whilst generating income for local communities from production of honey and other bee products.

Ninety households including women and men were selected randomly from the watershed to participate in the survey on the first phase of operational research installment. A general survey conducted using prepared checklist on the first phase of the ORTD project period to identify the Baseline information, which focused on all livestock production areas and Beekeeping, group discussions and key informants interview was used to generate necessary data on beekeeping and availability of important forages and the locally used system in the wet and dry season. From ninety selected households, forty/40/ farmers were selected for beekeeping technology transfer through Irish Aid approach and the group discussions was made with those farmers who started beekeeping using check list, which focused on Beekeeping inputs supply and new technologies, available flora resources, seasonality availability, flowering calendar, availability and area coverage land use patterns. Besides, secondary data, human and animal population, livestock production management, Bee production system and trend of honey production system was collected from the reports of the Woreda Office of Agriculture and Rural Development to augment primary data.

**Technology intervention approaches:** For the research installment, based on the survey data, 40 experianced farmers on beekeeping and who have atleast a traditional hives were selected, 2 modern zender model hives with two suppers were provided and thebee flora seeds and seedlings where given and planted on one common FTC selected on watershed areas or forest areas and those farmers were trained theoretically and practically to prepare the bee technologies from locally available materials and Other beehive eqiupments and accesseries were provide. Improved beeforage seeds or seedlings were provided for each members to cultivate on their own.The bee's production and productivity from those plant species will be assessed and the current level of productivity, households earn per month; their level of income from the flowers and bee product were estimated before and after intervention. Finally, Beekeeping provided income from the sale of honey, and additional income to farmers from the improved yields of crops that benefit from the increased pollination service. It remains to be seen if the income earned through these projects results in any environmental impacts. The income earned during the first few years has compared and the change analysed. The flora species with multi-purpose use are identified with farmer's response, the amount of flora on each farmer's site and their use at watershed is also identified and the technology status changes were scaled up and transferred to others through availing farmer's field visiting day.

**Statistical analyses:** The survey data and quantitative data was analyzed through the descriptive statistics such as tables of frequencies, graphs and means comparison using SPSS software statistical package. Visual observations, Success experiences and views of respondents were also used to explore qualitative data.

## Results and Discussions

**Land holding, human population and household characteristics:** The total land size of the watershed is 1210 ha. Of the total land size of the watershed about 1044 (75.7%) is allocated for annual crop production and 15.3% for perennial crop production, only 1.27% and 8% of the area are covered by forest and grazing land, respectively. About 79% and 21% of the land was owned by men and women headed households respectively. Mean household size was four. The total household of the study area is 1004 and the total human population is 5736.

The education level of 18%, 25%, 22% and 34% of the households was grades 7-12, 1-6, reading and writing and no education (illiterate) respectively.

Traditional beekeeping system in watershed existed with traditional skills and produced low mean amount of honey (4.1 kg) and poorly linked to watershed rehabilitation and conservation program regardless of beekeeping potential. Honey producers gained improved beekeeping skill to build the practical ability and confidence to be engaged in improved beekeeping. This increased the production of honey by improving the skill of beekeepers, based on economic and conservation contribution of beekeeping.

Table 1: Land holding and socioeconomic characteristics of beekeepers

| Characteristics of beekeeper | Mean | Minimum | maximum |
|---|---|---|---|
| Land size in ha | 1.35 | 0 | 3.0 |
| Family size (in number) | 4 | 1 | 7 |
| Age in years | 25 | 20 | 50 |
| Beekeeping experience in years | 5 | 1 | 18 |
| Honey yield from traditional in kg | 4.1 | 4 | 10 |

**Seasonal colony management trends on the watershed**

The technical efficiency of watershed beekeepers was increased to handle colonies aligned with rehabilitation of watershed flowering resources to increase the amount of harvested honey. The minority (43%) of beekeepers in watershed made their own intermediate hives and implemented and managed according to the seasonal variation of watershed bee forage. This provided watershed communities with an alternative source of income compared to the chopping down of trees to sell as charcoal from watershed. The watershed communities and their surrounding are increasingly more aware of the benefits of conserving their natural environment through harvesting sustainable honey and beeswax after the technology intervention (Table 2).

Table 2: Distribution of beekeepers performed seasonal bee management practices

| Seasonal colony management attributes | %of beekeepers practicing the colony management | |
|---|---|---|
| | %before intervention | % after intervention |
| Identifying and setting seasonal bee forge calendar | 20 | 65 |
| Seasonal inspection of bee colonies to prepare for good honey harvest | 24 | 62 |
| Feeding colonies to maintain dearth periods | 15 | 84 |
| Controlling bee pests and predators | 18 | 45 |
| Detect and harvest matured honey | 11 | 66 |
| Wax production and foundation making | 3 | 87 |
| Skill of queen rearing and colony splitting | 0 | 64 |

**Beekeeping status before and after intervention:** As the study result shows, there is a great enhanced change on the rehabilitation of the environment and hive products and bee production status in the watershed.

Table 3: Number of hives owned and bee forage planted before and after technology intervention (Mean ± Standard error).

| **Interventions** | Annual average honey yield in kg | Mean number of traditional hives owned | Mean number of transitional hives owned | Mean number of modern hives owned | Average forage planted |
|---|---|---|---|---|---|
| Before intervention | 14±12a | 2. 1± 0.221a | 0.1± 0.2a | 0.4± 0.8a | 37.2± 2.6a |
| After intervention | 25± 4.5b | 0.46± 0.02a | 2 ±0.3a | 3± 0.43b | 63± 13b |

**N.B.** Different letters show significant difference

**Livelihood activities and proportions:** Beekeeping provides income from the sale of honey, and it provides additional income to farmers from the improved yields of crops that benefit from the increased pollination service. It remains to be seen if the income earned through these projects results in any environmental impacts. The income earned during the first few years has compared. The revenue generated from beekeeping can help to alleviate pressure on the local resource base but the greater potential for beekeeping development to conserve biodiversity lies in the possibility of altering the way the local people view their environment, the income can make the connection between the health of the environment and livelihoods more tangible.

In view of the economic situation, it is unlikely that farmers were not set aside land for beekeeping and or bee flora production. However, forages could be grown as hedges around field edges and on soil bund, particularly on the sloping land. In the watershed area, after intervention of the technology, the total economic contribution proportions were, Maize (24.6%), teff (21%), wheat (15.1%), potato (20%) and beekeeping (19.8%) are the major crops grown in the watershed (figure 1).

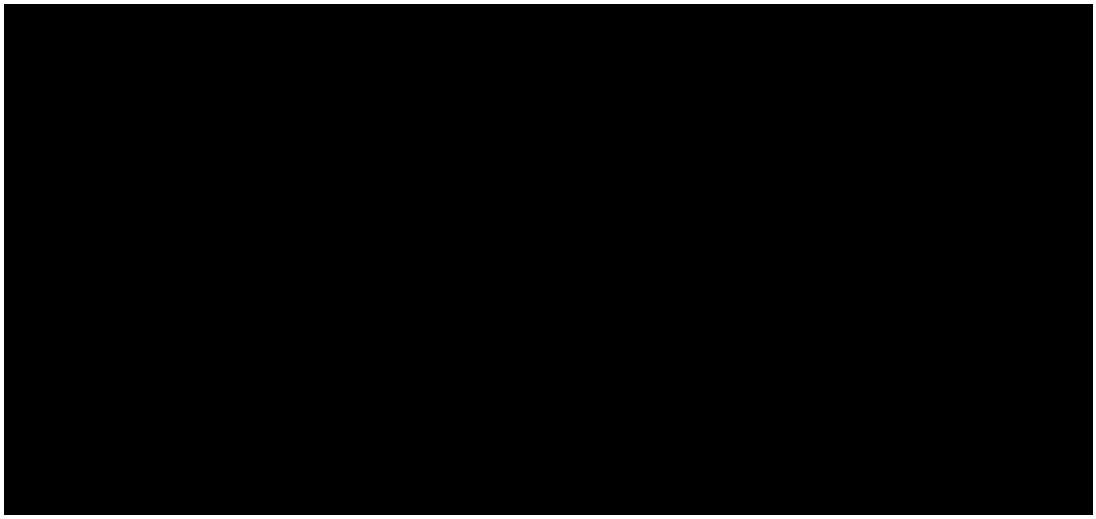

Figure 1: The livelihood commodities on the watershed (%).

**Bee Forage Planting:** The mean number of bee forage planted annually by the beekeepers before beekeeping intervention was 2 plants per sampled farmers and 24 plants per beekeepers after beekeeping intervention. The bee forage development has increased by 2 folds. Attitude of beekeepers towards watershed integrated beekeeping technology is a very important

phenomenon to take into consideration for multipurpose bee forages planting. Many countries introduced improved beekeeping as reforestation incentives, paying special attention to plant flowering trees that provide nectar and pollen whilst generating income for local communities from bee products (FAO, 2003; Steffan and Kuhn, 2003; Decourtye, *et al*, 2010). Diversification of cropping systems team such as vegetables, legumes, oilseeds, and forage crops in watershed improved the rainwater harvesting capacity and the impacts on environmental resources (Adugna, 2002). Crop varieties planted in watershed observed as major honeybee forage and important to maximize honey yield and spread the farmer's economic risk.

The plant species planted by the beekeepers before beekeeping intervention were mainly planted for fuel wood requirement, cash income and watershed conservation. Some of them are not visited by honeybees.

Guidelines and awareness were formulated by watershed beekeepers group to plant and maintain major bee forage trees, shrubs and herbs near homesteads, gully sides, river banks, hillsides and farm boundaries to increase honey production and important as watershed conservation. The approach is increased growing evidence for the positive link of beekeeping in conservation and there are successful experiences in integrating beekeeping with conservation.

Table 4: List of bee forage plant species newly adopted after the project

| Plant type/ species | Seedlings at farmers/FTC level | Addition use |
|---|---|---|
| Sweet clover | 50gm/30 seedlings | Homestead plant uses as flavor and major bee forage flowered at onset of rainy season, for conservation |
| Echuama tree | 28 seedlings | Homestead plant uses as flavor and major bee forage flowered at onset of rainy season, conservation |
| Vetch (vicia sativa) | 500gm | Animal forage and major bee flower at the end of rainy season |
| Vernonia | - | Homestead shrubs used for live fence, animal feed, medicinal and major bee forage flowered from January to February |
| phacillia | 500gm | Bee flora and for conservation |
| Cow pea | 500gm | Crop and foraged by bees |
| Lablab | 50gm | Animal forage, used for conservation and major bee flower at the end of rainy season |
| Luceania/tree Lucern | 80 seedlings | Bee flora and for conservation |
| Sesbania | 50 seedlings | Animal forage and major bee flower at the end of rainy season |
| cordia Africana | - | Agro-forestry tree important major honeybee flower and live fence flowered Sept-Nov |
| Gravillia robusta | - | Widely grown in all agro-ecology as live fence and major bee forage flowered from April to June |

These species are flowering plants and adopted and contributed to sustainable beekeeping development and watershed conservation in the area.

**Awareness on Value of bees for nature:**

Moreover, the crop growers benefited from the pollination services of the honeybees indirectly but not yet quantified.

Some types of plants depend uniquely on their pollination by bees (FAO, 2007). The ecological value of the pollination service of basin forest

communities, however, is often unknown. Bees also play an important role in pollinating crops. About one third of all plants or plant products eaten by humans depend directly or indirectly on bees for their pollination (FAO, 2009). Crops pollinated by bees have been proven to produce higher yields and better quality, often at no extra cost for the farmer. Yet, many farmers consider bees and other pollinators as harmful insects. The excessive use of pesticides in agriculture can harm bees directly and indirectly. Bees bring the pesticide-contaminated pollen and nectar toothier hive and slowly poison their offspring as the pollen and nectar are fed to the bees.

Therefore after this research intervention, there isa known and significant awareness among farmers and communities living around forests about the important role that bees play in agriculture and in maintaining biodiversity and ecosystems.

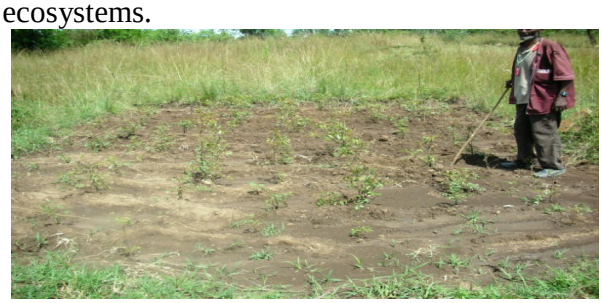

**Figure 1 and 2, Watershed before and after technology intervention respectively.**

A mixture of different weedy species maintained between crop boarders and uncultivated land of watershed contributed as major honeybee forage, rain water harvesting, watershed biodiversity conservation and climate adaption as well (Tolera Kumsa, 2014). Honeybees are the pre-eminent generalist pollinators as they are able to efficiently exploit a very wide range of floral resources (Schmidt and Edwards 1998) and consistently increase the level of pollination in many crops; hence their widespread use for this end (Huryn 1997).

**Watershed Rehabilitation and Bee Forage Improvement:** It is important however, to realize that for beekeeping to be become a sustainable activity, beekeepers need to be trained on best practices. The necessary financial, extensional and technological support to fully exploit the great potential of beekeeping in the conservation of forest and natural ecosystems and in poverty-reduction programmes should therefore be allocated.

**Figure 1, Apiary before intervention and figure 2, apiaries after technology awareness**

Watershed rehabilitation is recovering and or restoration of the watershed to the previous natural condition; and aims to increase the productivity of agricultural and other natural resources through a combination of re-vegetation and soil and water conservation (Turton, 2000).

**Potential role of beekeeping in poverty alleviation:** Beekeeping can be practiced as a safety net, providing households with extra income from the sales of honey and other

beehive products. At the same time, bee products are nutritious food that can be an extra source of energy and nutrients.

Honey can be easily stored, and sold or consumed in times of need. In the study watershed areas, farmers were aware and skilled on that beekeeping can be started up with few resources, even by landless households, as bees collect nectar where they can. It is not a labor-intensive activity and can therefore easily be combined with the other daily activities. Beekeepers on the study watershed were agreed and started forming and organizing themselves in Beekeeping Associations, improve their techniques, increase production and strengthen their position on the market.

**Types of Plant Species Preferred for Watershed Management:** Researchers together with farmers identified and aware to plant trees, shrubs and herbaceous plant species around homesteads, farm land and others. Therefore, integration of improved beekeeping technology with watershed management is very crucial to diversify the annual income of the household. It is an alternative income generating activities which can be an appropriate solution for sustainable watershed development and encourage the farmers toward tree planting. Therefore, integrating improved beekeeping.

**Role of Female son the beekeeping watershed:** Enhancing female farmers were one of the objectives of watershed management. As observed in the watershed, the participation of female farmers in the implementation of climate change adaptation mechanisms and benefits from the different interventions were lower. The discussion with the female households revealed that the main reason that female households were not participate well in the implementation of watershed were due to workload since they have internal (home) and external responsibilities and lower economic performance. However, after intervention of the ORTDP and delivering of training, the watershed performance in enhancing female farmer's livelihood were shown a significant difference with some efforts made than as usual.

**Attitude toward Improved Beekeeping:** Attitude of the beekeepers towards watershed integrated beekeeping technology is a very important phenomenon to take into consideration for sustainable adoption of improved beekeeping in watershed conservation. Farmers field visiting days facilitated and asked their response on the watershed status and they assured that they have developed awareness on the value of beekeeping for conservation and income generation as the result they have brought relatively better attitudinal change towards improved beekeeping technology and planting of different bee forage plants after this research demonstration.

**Figure 1, bee management before intervention and figure 2, management after intervention**

After technology intervention, it indicated that the majority of the watershed respondents (90%) had positive attitude towards watershed integrated beekeeping and honey production. However, 10 % of the respondents had neutral attitude and none of the respondents had negative attitude towards the technology in the study area. This showed how much the beekeeper farmers are understood the economical and ecological importance of beekeeping.

**Challenges on the beekeeping watershed:** It was revealed that lack of appropriate beekeeping knowledge (52%) and financial constraints (28%) were the most challenging obstacles to beekeeping at study watershed. As responded by village leaders, they have not been visited by beekeeping extension officers or being invited to any short course training for the past five years. According to Kumar (2010), beekeeping has potential to improve economic, social and health status of rural people if theoretical and practical training will be well conducted. But in reality, there is limited implementation of extension services especially on beekeeping services from most districts in the country which contribute significantly to under development of this sector.

Likewise, low household income among many villagers was known to limit villagers' capacity to purchase modern beekeeping equipments such as modern hives, harvesting gears and processing equipments. 95% of interviewed population mentioned that they are still using traditional hives made from logs because they are relatively cheaper and available locally.

Similarly, environmental factors particularly deforestation, bee enemies and agro-pollution was also identified to impact beekeeping area. Ants, wax moth, spiders were mentioned by District Beekeeping Officer to be the most harmful bee pests in the study area.

**Conclusion and Recommendations:** As a result of this intervention demonstration, the average annual income of the beekeeper household from honey sale has increased, indicating that the integration of beekeeping with conservation and rehabilitation of natural resources would be an important incentive to mobilize communities to participate in rehabilitation programs for both economic and environmental reasons. It is possible to conclude that, providing one beehive or bee colony is better for environmental conservation than telling the communities to plant a tree, since the former initiates the farmers to plant more trees on their own as the bees visit it. The bee forage growing practice of the beekeepers have increased and thus beekeepers have due regard for watershed management and planting multipurpose and or bee forages. Based on this study, this watershed is a suitable area to initiate bee farming. However, attention must be given to maintain the existing bee flora and multiplication of multipurpose bee plant species in order to make it sustainable. Cost of beekeeping equipment and lack of bee colony is also the other main bottle neck problem to expand beekeeping technology and therefore queen rearing technology is recommended to be enhanced in wide fashion as well as the demonstration and scaling up this technology should be promoted for sustainable watershed rehabilitation and to diversify the household income. It is also important to bring the voices of honey producers to the forefront of watershed conservation efforts and recommended that the government and stakeholders at all levels should provide technical services to align improved beekeeping to watershed conservation and all best practices will be scaled up so that honey production is increased and sustained.

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